March 2009

AIR DISPERSION MODELLING
GUIDELINE FOR ONTARIO

Version 2.0

Guidance for Demonstrating Compliance with

The Air Dispersion Modelling Requirements set out in

Ontario Regulation 419/05

Air Pollution – Local Air Quality

made under the *Environmental Protection Act*

PIBs # 5165e02

Protecting our environment. Ontario

FOREWORD

The "Air Dispersion Modelling Guideline for Ontario, version 2, March 2008" (the ADMGO Document) provides guidance on complying with the dispersion model requirements of Ontario Regulation 419/05: Air Pollution – Local Air Quality ("the Regulation"). This Regulation revoked and replaced Ontario Regulation 346 – General Air Quality.

The ADMGO Document is intended to provide guidance to ensure the fair and consistent implementation of the Regulation. This document is intended to be used in combination with the Ontario Ministry of the Environment (MOE) document, "Procedure for Preparing an Emission Summary and Dispersion Modelling Report, version 3, March 2008".

The MOE may periodically publish a list of questions and answers to assist in the interpretation of the ADMGO Document. The contents of this document may also be updated from time to time based upon public consultation consistent with the Ontario Environmental Bill of Rights legislation. All web site addresses referred to in this document were current at the time of release.

While every effort has been made to ensure the accuracy of the information contained in this ADMGO Document, it should not be construed as legal advice. In the event of conflict with requirements identified in the Regulation, then the regulatory requirements shall determine the appropriate approach.

For further details or to obtain copies of the approved dispersion models, regional meteorological files, or terrain data please contact:

Ministry of the Environment's Public Information Centre

135 St. Clair Avenue West, 1st floor, Toronto, ON M4V 1P5

Tel. 416-325-4000 or 1-800-565-4923, or

The MOE's internet site at www.ene.gov.on.ca

For any addenda or revisions to this guide please visit the MOE website at:

http://www.ene.gov.on.ca/envision/AIR/regulations/localquality.htm

Information may also be obtained from:

Ontario Ministry of the Environment

Air Monitoring and Reporting Section

Environmental Monitoring and Reporting Branch

125 Resources Rd, Toronto, ON M9P 3V6

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1.0 INTRODUCTION

Ontario Regulation 419/05: Air Pollution – Local Air Quality (hereafter referred to as "the Regulation") made under the *Environmental Protection Act* (EPA) is the general regulation governing air pollution in Ontario. This Regulation replaced and revoked Ontario Regulation 346 – General Air Pollution. The Regulation is intended to protect communities against adverse effects from local sources of air emissions. The Regulation places limits on the concentration of contaminants in the natural environment that are caused by emissions from a facility. The concentrations in the natural environment are calculated at a location referred to as a "Point of Impingement" which is defined in section 2 of the Regulation, as follows:

Points of impingement

"2. (1) A reference in this Regulation to a point of impingement with respect to the discharge of a contaminant does not include any point that is located on the same property as the source of contaminant.

(2) Despite subsection (1), a reference in this Regulation to a point of impingement with respect to the discharge of a contaminant includes a point that is located on the same property as the source of contaminant, if that point is located on,

(a) a child care facility; or

(b) a structure, if the primary purpose of the property on which the structure is located, and of the structure, is to serve as,

(i) a health care facility,

(ii) a senior citizens' residence or long-term care facility, or

(iii) an educational facility."

The Regulation requires that where a facility emits a contaminant into the air from one or more sources, the concentration in the atmosphere resulting from that contaminant at any point of impingement (POI) must be less than the standard prescribed in the Regulation. For further information, please refer to sections 18, 19, and 20 of the Regulation.

In addition to the standards set out in the Regulation, the Ontario Ministry of the Environment (MOE) also uses a broader list of point of impingement guidelines (MOE POI Limits)[1] to assist in preventing adverse effects that may be caused by local sources of air pollution.

Demonstrating compliance with the Regulation begins with development of an Emission Summary and Dispersion Modelling (ESDM) Report. A summary of total site air emissions are calculated and are then converted to point of impingement concentrations using mathematical air dispersion models. The “Procedure for Preparing an Emission Summary and Dispersion Modelling Report” (the ESDM Procedure Document) provides guidance on complying with the ESDM report content requirements set out in section 26 of the Regulation and should be used in conjunction with this Air Dispersion Modelling Guideline for Ontario (ADMGO) Document to assess compliance.

Earlier versions of the regulation (previously known as Regulation 346 – General Air Pollution Regulation) included a set of air dispersion models in the Appendix to Regulation 346. The models in the Appendix to Regulation 346 will be phased out and replaced with new air dispersion models developed by the United States Environmental Protection Agency (US EPA) as set out in Chapter 1.1 below.

1.1 *Application of the Dispersion Models in the Regulation*

The Regulation provides for a staggered phase-out (between 2010 and 2020) of the models in the Appendix to Regulation 346[2], according to a schedule that varies by industrial sector (using the North American Industry Classification System (NAICS)).

Subsection 6 (1) of the Regulation lists the “approved dispersion models” which include (i) three US EPA dispersion models: SCREEN3, AERMOD and ISCPRIME; (ii) the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) method of calculations for Building Air Intake and Exhaust Design (see

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[1] The MOE uses a combination of air quality standards in the Regulation and a broader list of point of impingement guidelines available from www.ene.gov.on.ca/publications/6570e-chem.pdf. The generic term "limits" in the context of this guideline means any numerical concentration limit set by the MOE including standards in the schedules to the Regulation, guidelines and recommended levels for chemicals with no standard or guideline. Furthermore, where the Regulation uses language similar to “sections 18, 19 and 20 do not apply to discharges of the contaminant and the Director has reasonable grounds to believe that, if the source of contaminant is considered, a discharge of the relevant contaminant may cause an adverse effect” it is intended that persons compare contaminant concentrations to those guidelines and recommended levels.

[2] The Regulation defines the “Appendix to Regulation 346” as the Appendix to Regulation 346 of the Revised Regulations of Ontario, 1990 (General — Air Pollution) made under the Act, as that regulation read immediately before it was revoked on November 30, 2005. The “Appendix to Regulation 346” is available from the Ministry of the Environment (MOE) (see www.ene.gov.on.ca or the Public Information Centre).

section 9 of the Regulation, Same Structure Contamination); and (iii) the models in the Appendix to Regulation 346.

The "approved dispersion models" in the Regulation are required to be used when assessing compliance with the standards in Schedules 1, 2 and 3 (in accordance with sections 18, 19 and 20 of the Regulation) and MOE POI Limits. Note, however, that the models in the Appendix to Regulation 346 are only considered to be an "approved model" if sections18 or 19 apply to discharges from the facility.

Section 6 of the Regulation defines approved dispersion models for the purposes of parts of the Regulation as follows:

Approved dispersion models

6. (1) For the purposes of this Part, the following are approved dispersion models for discharges of a contaminant, except as otherwise provided:

1. The AERMOD dispersion model made available on the Internet by the United States Environmental Protection Agency, as amended from time to time, or a copy of that model that is available from the Ministry.

2. The ASHRAE method of calculation.

3. The ISCPRIME dispersion model made available on the Internet by the United States Environmental Protection Agency, as amended from time to time, or a copy of that model that is available from the Ministry.

4. The SCREEN3 dispersion model made available on the Internet by the United States Environmental Protection Agency, as amended from time to time, or a copy of that model that is available from the Ministry.

5. The method of calculation required by the Appendix to Regulation 346, if section 18 or 19 applies to the discharges.

(2) The Ministry shall make copies of the approved dispersion models referred to in paragraphs 1, 3, 4 and 5 of subsection (1) available through a website maintained by the Ministry on the Internet or through the Ministry's Public Information Centre.

The US EPA models referred to in Section 6 of the Regulation are available on the US EPA website. The ASHRAE method of calculation is copyrighted and a licence to use these methods must be purchased from the American Society of Heating, Refrigerating and Air-Conditioning Engineers (www.ashrae.org).

The approved dispersion models work in conjunction with the air quality standards in Schedules 1, 2 and 3 of the Regulation. Please refer to Sections 18, 19 and 20 of the Regulation to determine which of Schedules 1, 2 or 3, respectively applies. The amendments to the Regulation in 2007 expanded the choice of approved models to be used to show compliance with Schedule 1 or 2. The models work in conjunction with the standards as follows:

- To demonstrate compliance with the half-hour average standards listed in Schedules 1 and 2 of Regulation, any of the approved models may be used (after appropriate conversion of time averaging periods is made as per section 17 of the Regulation).

- To demonstrate compliance with the standards listed in Schedule 3 of the Regulation, any of the approved dispersion models, **except for** the models in the Appendix to Regulation 346, may be used.

1.2 *Phasing-Out the Models in the Appendix to Regulation 346*

The staged phase-out of the **models in the Appendix to Regulation 346** is set out in sections 18, 19 and 20 of the Regulation. In general, the phase-out is as described below:

- Until February 1, 2010, facilities may use any of the models listed in s.6 of the Regulation, including the models in the Appendix to Regulation 346, to assess compliance with the air quality standards in Schedule 1. A notice can be issued by an MOE Director prior to the phase in period to assess compliance with Schedule 3 standards using one of the more advanced US EPA models (please refer to subsection 20(4) of the Regulation). However, such facilities would not be required to comply with the Schedule 3 standards until their phase-in date or February 1, 2010, if the facility is not in a sector listed in Schedule 4 and the Director issues an Order under 20(5) of the Regulation.

- On or After February 1, 2010, facilities may use any of the models listed in s.6 of the Regulation, including the models in the Appendix to Regulation 346, to assess compliance with the air quality standards in Schedule 2. However, facilities within the sectors listed in Schedule 4 may only choose from SCREEN3; ISCPRIME; or AERMOD to assess compliance with the air quality standards in Schedule 3 and must assess same structure contamination using the ASHRAE method. .

- On or After February 1, 2013, facilities may use any of the models listed in s.6 of the Regulation, including the models in the Appendix to Regulation 346, to assess compliance with the air quality standards in Schedule 2. However, facilities within the sectors listed in Schedule 4 or Schedule 5 may only choose from SCREEN3; ISCPRIME; or AERMOD to assess compliance with the air quality standards in Schedule 3 and must assess same structure contamination using the ASHRAE method.

- On or After February 1, 2020, all facilities may only choose from SCREEN3; ISCPRIME; or AERMOD to assess compliance with the air quality standards in Schedule 3. All facilities must use the ASHRAE method to assess same structure contamination.

- As of November 30, 2005 (the day the Regulation came into force), all new facilities[3] within sectors identified in Schedules 4 or 5 of the Regulation, may only choose from SCREEN3; ISCPRIME; or AERMOD to assess compliance with the air quality standards in Schedule 3. New facilities in sectors listed in Schedules 4 or 5 are also required to use ASHRAE to assess same structure contamination.

Note that the ASHRAE method may be used by any facility in advance of the mandatory phase-in dates of the Schedule 3 standards to assess same structure contamination using the applicable Schedule 1 or Schedule 2 half hour standards. Similarly, the SCREEN3, ISCPRIME and AERMOD models may be used in advance of the mandatory phase-in dates to assess maximum POI concentrations using applicable Schedule 1 or Schedule 2 half hour standards (see section 17 of the Regulation). Only if a facility desires to use the Schedule 3 standards as their compliance point is Ministry of the Environment (MOE) approval required via a section 20(4) notice.

The models in the Appendix to Regulation 346 are available from the MOE website at: www.ene.gov.on.ca/envision/gp/4244e.htm. Copies of SCREEN3, ISCPRIME and AERMOD can be obtained from the United States Environmental Protection Agency (US EPA) web-site at: www.epa.gov/ttn/scram/ as well as through a website maintained by the MOE on the Internet or through the Ministry's Public Information Centre (see www.ene.gov.on.ca). The ASHRAE method of calculation is copyrighted and a licence to use these methods must be purchased from the American Society of Heating, Refrigerating and Air-Conditioning Engineers (www.ashrae.org).

[3] "New facility" means that construction of the facility began after November 30, 2005 and no application for a Certificate of Approval was made on or before that day, For clarity, the term 'new facility' does NOT refer to a modification or expansion of an existing facility; nor installation of a new process at an existing facility.

1.3 *Specified Dispersion Models*

Section 7 of the Regulation generally states that where a model is at least as accurate for that facility as an approved model, the Director may add it to the list of approved models for that facility. Conversely, where a model is less accurate than an approved model (or other model that the facility has been notified to use under section 7), the Director may remove it from the list of approved models for that facility.

In summary, subsection 7(1) allows that where the Director feels that a model may predict more accurately than another, the Director may tell a person to use:

- a specific approved model
- another dispersion model (e.g. alternative model) or
- a combination of models or a combination of models and monitoring

Specifically, subsection 7(1) of the Regulation states:

Specified dispersion models

"7. (1) The Director may give written notice to a person who discharges or causes or permits the discharge of contaminants from a property stating that the Director is of the opinion that, with respect to discharges of a contaminant from that property,

(a) one or more dispersion models specified in the notice would predict concentrations of the contaminant at least as accurately as an approved dispersion model;

(b) a combination specified in the notice of two or more dispersion models would predict concentrations of the contaminant at least as accurately as an approved dispersion model;

(c) a combination specified in the notice of one or more dispersion models and one or more sampling and measuring techniques would predict concentrations of the contaminant at least as accurately as an approved dispersion model; or

(d) one or more approved dispersion models specified in the notice would predict concentrations of the contaminant less accurately than,

(i) a dispersion model or combination specified under clause (a), (b) or (c), or

(ii) another approved dispersion model.

(2) Before the Director gives a person a notice under subsection (1), the Director shall give the person a draft of the notice and an opportunity to make written submissions to the Director during the period that ends 30 days after the draft is given.

(3) If a notice is given under subsection (1) with respect to discharges of a contaminant from a property, a reference in this Part to an approved dispersion model shall be deemed, with respect to those discharges,

(a) to include a dispersion model or combination specified under clause (1) (a), (b) or (c); and

(b) not to include a dispersion model that is specified under clause (1) (d)."

For example, in the appropriate circumstances, the Director may remove SCREEN3, ISCPRIME and AERMOD and add CALPUFF to the list of approved models for the facility. Accordingly, the facility would then be required to assess compliance using only CALPUFF. A MOE Director may implement the above, by written notice. Note, however, that such a notice would not be effective for compliance purposes until section 20 began applying to the facility (see subsections 7(8) and (9) of the Regulation). The application of section 20 can be "sped up" if the facility requests a notice under subsection 20(4) or if the Director orders it under subsection 20(5) - (the Regulation does not allow the issuance of such an Order prior to February 1, 2010).

Subsections 7(4) to 7(12) of the Regulation include requirements on how the specified dispersion models will be used in terms of timing; reference to "approved dispersion models", ESDM reports and standards.

Specified dispersion models

"7. (4) Subsection (3) applies in respect of all contaminants unless the notice given under subsection (1) provides that subsection (3) applies only in respect of contaminants specified in the notice.

(5) Subsection (3) does not apply to a discharge of a contaminant until,

(a) three months after the notice is given under subsection (1), unless clause (b) applies; or

(b) one year after the notice is given under subsection (1), if the notice includes a notice under clause (1) (c).

(6) Subsection (5) does not apply for the purpose of preparing a report to which subsection 23 (3), 24 (2), 30 (5) or 32 (16) applies.

(7) Subsection (5) does not apply to a discharge of a contaminant if subsection (3) would have the effect of permitting the discharge.

(8) If a notice is given to a person under subsection (1) and section 20 does not apply to the person in respect of a contaminant, subsection (3) applies to the person in respect of the contaminant only after section 20 begins to apply to the person in respect of the contaminant.

(9) Despite subsection (8), if a notice is given to a person under subsection (1) and section 20 does not apply to the person in respect of a contaminant, subsection (3) applies to the person in respect of the contaminant for the purpose of preparing a report to which subsection 23

(3), 24 (2), 30 (5) or 32 (16) applies.

(10) The Director may, by written notice, revoke a notice given under subsection (1).

(11) Subsection (3) ceases to apply to discharges of the contaminant three months after the notice is given under subsection (10).

(12) Despite subsection (11), subsection (3) does not apply to a discharge of a contaminant after the notice is given under subsection (10) if subsection (3) would have the effect of prohibiting a discharge that would otherwise be permitted."

Subsection 7(5) of the Regulation states that the specified use of a dispersion model as an approved model is not applicable until three months (or one year if monitoring is involved) after the issuance of a written notice by the Director. Subsection 7(7) clarifies that the three month delay, before the required use of the specified model, is not applicable if the specified model would enable the facility to demonstrate compliance with the standard.

2.0 OVERVIEW OF THE APPROVED DISPERSION MODELS

2.1 *Modelling Overview*

Air dispersion modelling is the mathematical assessment of contaminant impacts from emissions sources within a study area. Factors that impact the fate and transport of contaminants in the atmosphere include meteorological conditions, site configuration, emission release characteristics and surrounding terrain, amongst others.

2.2 *Overview of the Models in the Appendix to Regulation 346*

The models in the Appendix to Regulation 346 consist of the following three models:

- The Scorer and Barrett model/equation for use in calculating points of impingement concentrations relatively close to the source of emission (i.e., up to 5 metres away from the building or structure on which the point of emission is located).
- The Virtual Source dispersion model for use in calculating point of impingement concentrations from stacks and vents that are generally less than twice the height, above grade, of the building that the stack or vent is on.
- The point source dispersion model for use with stacks that are generally greater than twice the height, above grade, of the building that the stack or vent is on.

The virtual source and the point source models have been translated into a software program known as the Regulation 346 Dispersion Modelling Package available at: www.ene.gov.on.ca/envision/gp/4244e.htm. This software package has been set up to search through the slightly unstable and neutral meteorological conditions[4] specified in the Appendix to Regulation 346 to identify the meteorological condition which will give the highest half-hour average concentration at a point of impingement. The program is designed to search through all ground-level receptors off the facility's property to find the maximum half-hour average concentration. In addition, the Regulation 346 Package can calculate the concentration at specific points of impingement, such as air intakes on the roofs of nearby buildings or

[4] The models in the Appendix to Regulation 346 use slightly unstable and neutral conditions referred to as C and D atmospheric stabilities but does not include the unstable conditions identified as A and B atmospheric stability nor the stable conditions, identified as E and F atmospheric stability.

impingement on the sides or roof of an apartment building. See Appendix C for instructions on the use of the models in the Appendix to Regulation 346.

2.3 Overview of SCREEN3, ISCPRIME, AERMOD and ASHRAE

Ontario's approved dispersion models include SCREEN3 for screening analyses and AERMOD or ISCPRIME for more sophisticated modelling analyses. In addition, the ASHRAE model must be used as necessary to assess potential for contamination of building air intakes (see section 9 of the Regulation). SCREEN3, AERMOD, or ISCPRIME are used for assessment of POI concentrations at the POIs that are not located on the same structure as the source of contaminant. A brief overview of each of these models can be found below. For appropriate model selection, please review Chapter 2.3.1 – 2.3.5 below, as appropriate that outline the details of each of the following air dispersion models:

- AERMOD
- ISCPRIME
- SCREEN3
- ASHRAE (same structure contamination)

2.3.1 AERMOD

The AERMIC (American Meteorological Society/EPA Regulatory Model Improvement Committee) Regulatory Model, AERMOD[1,2,3] was specially designed to support the US EPA's regulatory modelling programs. AERMOD is the next-generation air dispersion model that incorporates concepts such as planetary boundary layer theory and advanced methods for handling complex terrain. AERMOD was developed to replace the Industrial Source Complex Model-Short Term (ISCST3) as US EPA's approved model for most small scale regulatory applications[4,5]. The Plume Rise Model Enhancements (PRIME) building downwash algorithms were incorporated into AERMOD. This provides a more realistic handling of downwash effects than previous approaches.

The Plume Rise Model Enhancements (PRIME) algorithm was designed to incorporate two fundamental features associated with building downwash:

- Enhanced plume dispersion coefficients due to the turbulent wake.
- Reduced plume rise caused by a combination of the descending streamlines in the lee of the building and the increased entrainment in the wake.

BPIP-PRIME (Building Profile Input Program) must be used to generate the necessary PRIME downwash parameters which then form part of the input file for AERMOD.

AERMOD contains basically the same options as the ISCPRIME with a few exceptions, which are described below:

- AERMOD requires two types of meteorological data files, a file containing surface scalar parameters and a file containing vertical profiles. These two files are produced by the US EPA AERMET meteorological pre-processor program[6].
- For applications involving elevated terrain, the user must also input a hill height scale along with the receptor elevation. The US EPA AERMAP terrain pre-processing program[7] can be used to generate hill height scales as well as terrain elevations for all receptor locations.
- The urban option in AERMOD results in altering dispersion parameters due to the urban heat island effect. The urban population is an input to this option.
- AERMOD has additional types of area sources (circular, polygon).
- AERMOD does not have an option for varying emission rates by stability class.

The options AERMOD has in common with ISCPRIME are described in Chapter 2.3.4.

2.3.2 ISCPRIME Overview

The ISCPRIME[9,10] dispersion model is a steady-state Gaussian plume model, which can be used to assess contaminant concentrations, and deposition fluxes from a wide variety of sources associated with an industrial source complex. The ISC series of dispersion models from the US EPA were developed to support the EPA's regulatory modelling options, as specified in the US EPA *Guidelines on Air Quality Models (Revised)*[8].

The ISCPRIME model has integrated the PRIME downwash algorithms into the model. To be able to run the ISCPRIME model for a case that involves building downwash, a proponent must first perform building downwash analysis using BPIP-PRIME. For more information on building downwash please refer to Chapter 4.6 - Building Impacts.

Some of the ISCPRIME modelling capabilities are that the model:

- may be used to model contaminant emissions from many sources and continuous releases of contaminants.
- can handle multiple source types, including point, volume, area and open pit source types. Line sources may also be modelled as a string of volume sources or as elongated area sources.
- enables source emission rates to be treated as constant or varied by month, season, hour-of-day, or other optional periods of variation. These variable emission rate factors may be specified for a single source or for a group of sources.
- can account for the effects of aerodynamic downwash due to nearby buildings on point source emissions.
- contains algorithms for modelling the effects of settling and removal (through dry deposition) of large particulates and for modelling the effects of precipitation scavenging for gases or particulates.
- has receptor locations that can be specified as gridded and/or discrete receptors in a Cartesian or polar coordinate system.
- incorporates the COMPLEX1 complex terrain screening model dispersion algorithms which are less accurate than the algorithm in AERMOD.
- uses real hourly meteorological data to account for the atmospheric conditions that affect the distribution of air pollution impacts on the modelling area.
- yields results that can be output for concentration, total deposition flux, dry deposition flux, and/or wet deposition flux.

Unlike AERMOD, ISCPRIME does not contain a terrain pre-processor. As a result, receptor elevation data must be obtained through alternative means. The use of an inverse distance algorithm for interpolating representative receptor elevations is an effective method.

2.3.3 SCREEN3 Overview

The SCREEN3 model was developed to provide an easy-to-use method of obtaining contaminant concentration estimates. These estimates are based on the US EPA document "Screening Procedures for Estimating the Air Quality Impact of Stationary Sources"(11).

The SCREEN3[12] model can perform all the single source short-term calculations in the EPA screening procedures document, including:

- estimating a full range of stability class and wind speeds to find maximum hourly ground-level concentrations and the distance to the maximum. Maximum concentrations can be calculated at a range of downwind distances.
- incorporating the effects of building downwash on the maximum concentrations for both the near wake and far wake regions.
- estimating concentrations in the cavity recirculation zone.
- estimating concentrations due to inversion break-up and shoreline fumigation.
- determining plume rise for flare releases.
- incorporating the effects of simple elevated terrain (i.e., terrain not above stack top) on maximum concentrations.
- modelling simple area sources using a numerical integration approach.
- estimating 24-hour average concentrations due to plume impaction in complex terrain (i.e., terrain above stack top) using the VALLEY model 24-hour screening procedure.

2.3.4 ISCPRIME and AERMOD Model Comparison

The ISCPRIME and AERMOD models share several similarities:

- Both are steady state plume models.
- AERMOD input and output are intentionally similar to ISCPRIME for ease of use.

AERMOD is a next-generation model, and while input and output may share similarities in format, there are several differences as detailed in Table 2-1.

Table 2-1: Differences between ISCPRIME and AERMOD

ISCPRIME	AERMOD
Plume is always Gaussian	Plume is non-Gaussian when appropriate
Dispersion is function of six stability classes only	Dispersion is function of continuous stability parameters and height
Measured turbulence cannot be used	Measured turbulence can be used
Wind speed is scaled to stack height	Calculates effective speed through the plume
Mixing height is interpolated	Mixing height is calculated from meteorological data
Plume either totally penetrates the inversion, or not at all	Plume may partially penetrate the inversion at the mixing height
Terrain is treated very simplistically	More realistic terrain treatment, using dividing streamline concept
Uses single dispersion for all urban areas	Adjusts dispersion to size of urban area

This Table contains two columns and one row header. The first and second columns compare differences between ISCPRIME and AERMOD respectively.

2.3.5 Use of ASHRAE - Same Structure Contamination Model

Improper stack design and configuration can lead to impacts beyond ground level contamination. The influence of buildings on contaminant emissions is examined in Chapter 4.6 - Building Impacts. The interactions between sources and buildings can also lead to situations of emission re-entry into nearby buildings. Many buildings have air-handling units located on their rooftops. As a result, it is important to ensure that emissions from rooftop sources do not allow plume impact on their rooftops, or nearby buildings.

The American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) Handbook describes a methodology for proper stack design to avoid re-entrainment of contaminants. The Chapter titled “Building Air Intake and Exhaust Design” in the ASHRAE Applications Handbook, as amended or revised from time to time (Chapter 44 in the 2007 ASHRAE Handbook[(13)]), provides analytical approaches for determining impacts on receptors (in this case, typically air intakes) for a series of stack/rooftop configurations including:

- Strong Jets in Flow Recirculation Cavity
- Strong Jets on Multi-winged Buildings

- Exhausts with Zero Stack Height

Same structure contamination becomes especially important within industrial parks, or multi-unit commercial complexes where emissions from one unit can impact neighbouring units (where the neighbouring unit is within the same structure as the emission source) through air intakes, open doors, or windows. The ASHRAE model is for use with respect to a point of impingement that is located on the same structure as the source of contaminant. Recall that “point of impingement” is defined in section 2 of the Regulation. In general terms, a point of impingement (POI) includes: (a) any point off-site; and (b) any point on-site that is (a) on a child care facility; or (b) on a structure that serves primarily as a health care facility, a senior citizens’ residence or long-term care facility, or an educational facility. In situations where there are multiple structures located in close proximity to one another, contact MOE (EMRB) for additional guidance as to whether they should be considered to be a single structure.

Section 6 of the Regulation lists the ASHRAE method of calculation as an approved dispersion model. ASHRAE is to be used as the approved dispersion model for special “same structure contamination” situations. Section 9 of the Regulation states:

Same structure contamination

9. (1) The following approved dispersion models are the only approved dispersion models that may be used for the purposes of this Part with respect to the contaminant and a point of impingement that is located on the same structure as the source of contaminant:

1. ***The ASHRAE method of calculation.***
2. ***A dispersion model or combination of dispersion models that, pursuant to subsection 7 (3), is deemed to be included in references in this Part to approved dispersion models, if the notice given under subsection 7 (1) states that the Director is of the opinion that the dispersion model or combination of dispersion models would predict concentrations of the contaminant at least as accurately as the ASHRAE method of calculation.***
3. ***The method of calculation required by the Appendix to Regulation 346, if section 18 or 19 applies to discharges of the contaminant.***

(2) The ASHRAE method of calculation may be used for the purposes of this Part with respect to a contaminant only with respect to a point of impingement that is located on the same structure as the source of contaminant.

Section 9 of the Regulation sets out that, when the points of impingement are located on the same structure as the source of emission of the contaminant, a person may choose to use ASHRAE (with appropriate time averaging under s.17, if necessary), as the approved dispersion model or the Scorer and Barrett calculation in the Appendix to Regulation 346. However, when s.20 begins to apply to a person they must use either ASHRAE or an alternative model approved by the Director under section 7 of the Regulation.

The ASHRAE method can determine concentrations for averaging periods between 2 minutes and 180 minutes. Where ASHRAE cannot accommodate the averaging period of the standard, then the 1-hour concentration should be determined and converted to the appropriate averaging time for that contaminant using the equations set out in section 17 of the Regulation.

The emission rate (contaminant mass release rate) must correspond to the averaging time period of the MOE POI limit in accordance with section 11 of the Regulation.

It should be noted that proponents assessing same structure contamination using one of the approaches described above must also assess compliance with MOE POI Limits at other off-property POI locations using one of the appropriate approved dispersion models listed in section 6 of the Regulation.

2.4 Alternative Models

Alternative models may be used if conditions warrant their use and the models are approved by the MOE. These alternative models may be used instead of or to complement MOE's list of approved models (subject to MOE Approval). The following list contains alternative models that are currently accepted by MOE for consideration. Please see Appendix A for terms of appropriate use and required supporting explanations.

- CALPUFF
- CAL3QHCR
- SDM – Shoreline Dispersion Model
- Physical Modelling

MOE may consider other models where a proponent can demonstrate that the alternative dispersion model is at least as accurate as an approved model. In accordance with section 7 of the Regulation (see Chapter 1.3 of this ADMGO document for an excerpt of section 7 of the Regulation) the Director may approve the use of an alternate model by issuing a Notice, if he/she is of the opinion that the specified model would be at least as accurate as an approved model.

3.0 A TIERED APPROACH FOR ASSESSING COMPLIANCE WITH MOE POI LIMITS USING SCREEN3, ISCPRIME OR AERMOD

As set out in s.6 of the Regulation, a person may use the models in the Appendix to Regulation 346, SCREEN3, ISCPRIME or AERMOD to assess compliance with the standards in Schedules 1 and 2 of the Regulation. In some situations, a conversion to the relevant averaging period of a standard will have to be performed (please refer to s.17 of the Regulation for authorized conversion calculations). If a facility that is subject to sections 18 or 19 of the Regulation (i.e. Schedule 1 or 2 standards apply) desires to use the Schedule 3 standards as their compliance point, MOE approval is required via a section 20(4) notice.

Section 6 of the Regulation also sets out that any of the three US EPA approved dispersion models (SCREEN3, ISCPRIME or AERMOD) can be used to assess compliance with the standards in Schedule 3 (subject to the section 7 of the Regulation – Specified Dispersion Models).

The SCREEN3 dispersion model is simpler and generally more “conservative”[5] in assessing point of impingement concentrations than the other two US EPA approved dispersion models listed in section 6 of the Regulation. As a result, it is often appropriate to initially calculate a point of impingement concentration using SCREEN3.

The ISCPRIME and AERMOD dispersion models use input data for parameters such as meteorology, local land use and terrain. However, it is reasonable to use simplified data inputs when the selected data results in conservative assessments of point of impingement concentrations. As a result, a modelling assessment may consist of a series of modelling steps. The MOE refers to this step-wise method to modelling as a tiered approach.

A tiered approach to air dispersion modelling is commonly used and is presented in Figure 3.1. This approach focuses the required level of effort according to site requirements. It should be noted that any of the three tiers may be performed and linear progression through each tier is not necessary. More sophisticated modelling techniques would need to be applied each time a successive screen showed an exceedence of MOE POI Limits. Successive screens combined with improved data quality as required by section 12 of the Regulation and in the ESDM Procedure Document, means that the last tier would require the most sophisticated modelling and emission estimating techniques, and would be the most representative of actual on-site conditions and contaminant concentrations.

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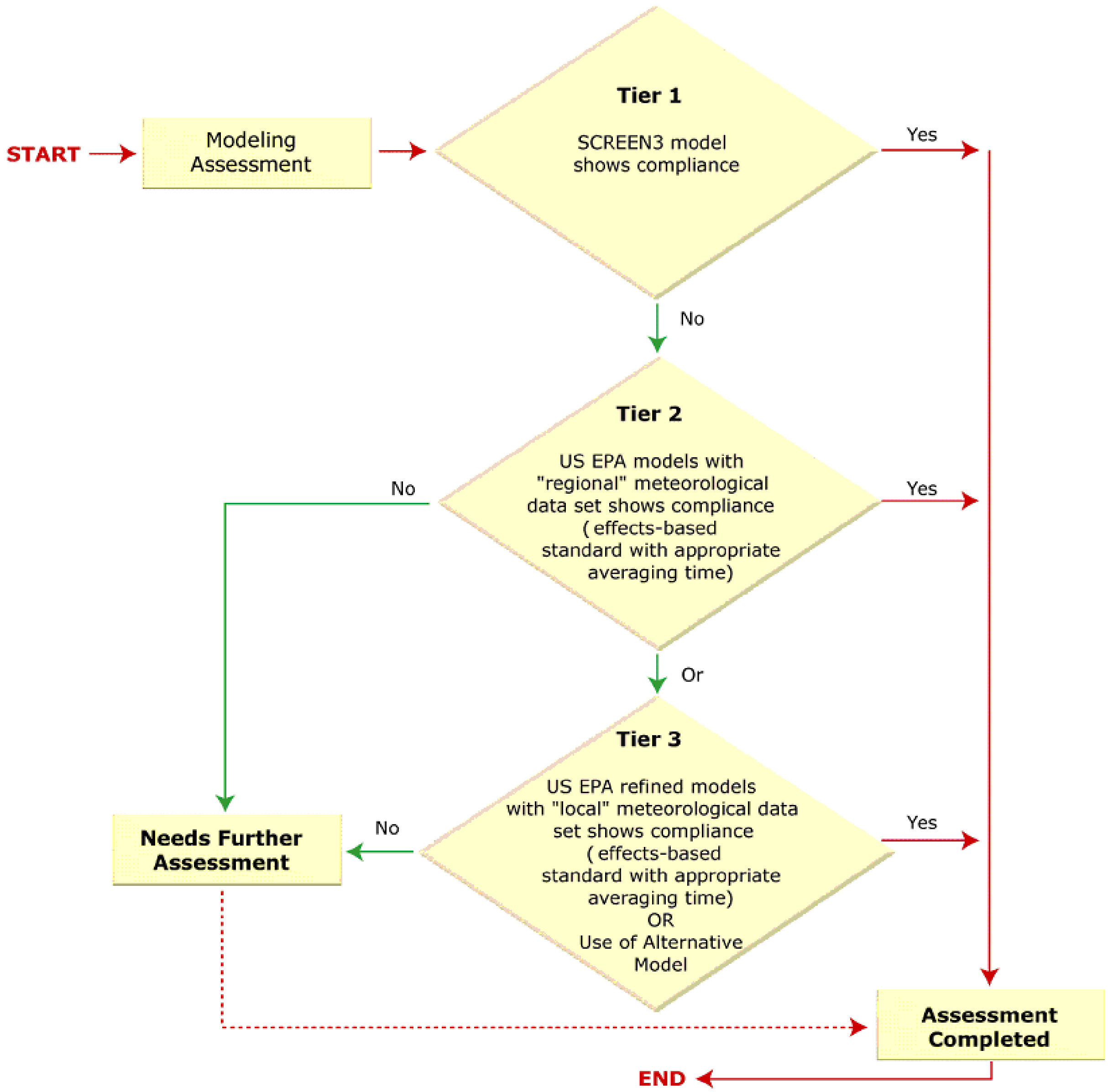
[5] For the purpose of this ADMGO Document the term “conservative” refers to an assessed POI concentration that is certain to be higher than the actual concentration.

Figure 3.1: Tiered Modelling Approach Flow Diagram



A Tier 1 assessment represents the most conservative assumptions about meteorological conditions and modelling inputs. To complete a Tier 1 assessment, a proponent shall use conservative dispersion modelling factors or the SCREEN3 model. For facilities that have multiple sources, ISCPRIME may be used in combination with an MOE-prepared screening-level meteorological data set that incorporates the full range of wind directions and meteorological conditions.

Tier 2 and 3 modelling assessments represent more sophisticated, precise and accurate modelling inputs and scenarios. The most significant difference between Tier 2 and 3 assessments is the use of more site specific or local meteorological data inputs. To complete a Tier 2 assessment, the proponent shall use the pre-

processed regional meteorological data made available by the MOE (see Chapter 3.2 below for data sets). A Tier 3 assessment requires the use of more site specific meteorological data approved by the Director (e.g. the data required in subsections 13(1) paragraphs 3 and 4 of the Regulation). In Tier 3 assessments, the MOE may also consider alternative models that may be more representative of local conditions and produce more representative concentrations for specific contaminants.

The Tier 2 and Tier 3 modelling assessments calculate each hour of the meteorological data set, which allows for specifying emission rates appropriate to the hour of the day and day of week both for the hourly average and 24 hour average derivations (i.e., a variable emission rate scenario). For more information on estimating emission rates, refer to the ESDM Procedure Document.

Any proponent may choose to go directly to the more sophisticated modelling techniques (Tier 2 or 3) and skip the initial Tier 1 of the screening methods if they so choose. In some situations, such as with complex facilities, the MOE may require a proponent to proceed to Tier 2 or 3 directly.

3.1 Tier 1 Modelling

Tier 1 is a screening level analysis and shall be completed using either conservative dispersion factors provided in Table 3.1 or a screening model such as the US EPA SCREEN3 model, which requires no input of meteorological data as it includes all potential worst case meteorological conditions. Tier 1 may also be completed using a Tier 2 model in combination with an MOE-prepared screening-level meteorological data set (available upon request) that incorporates the full range of wind directions and meteorological conditions. If a Tier 1 conservative modelling assessment demonstrates compliance with MOE POI Limits, there is no need for additional modelling.

3.1.1 Use of Conservative Dispersion Modelling Factors

Conservative dispersion modelling factors can be used to conservatively screen out contaminants with insignificant (negligible[6]) emissions from further modelling analyses. These factors can also be used to conservatively but simply assess the insignificant sources of a contaminant on a facility, consistent with section 8 of the Regulation. For more information regarding insignificant sources, refer to the MOE ESDM Procedure Document.

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[6] Note: The Regulation uses the term ‘negligible’ in reference to contaminants that are emitted in amounts too small to be relevant and may be excluded from the assessment of compliance with the air quality standards in the Regulation and MOE POI Limits. The term ‘not negligible’ is also used in the Regulation. For the purposes of the guidance information contained in the ESDM Procedure Document and ADMGO, the term ‘insignificant’ is synonymous with ‘negligible’ and ‘significant’ synonymous with the term ‘not negligible’.

Negligible sources of contaminant

"8. (1) It is not necessary, when using an approved dispersion model for the purposes of this Part, to consider a source of contaminant that discharges a negligible amount of the relevant contaminant, having regard to,

(a) ***the total amount of the contaminant that is discharged by all the sources of contaminant with which the approved dispersion model is used; and***

(b) the nature of the contaminant.

(2) Despite subsection (1), the Director may give written notice to a person who discharges or causes or permits discharges of contaminants requiring the person to consider a source of contaminant specified in the notice in accordance with the notice when the person uses an approved dispersion model for the purposes of this Part, if,

(a) the Director has reasonable grounds to believe that, if the source of contaminant is considered, the person may contravene section 18, 19 or 20; or

(b) Sections 18, 19 and 20 do not apply to discharges of the relevant contaminant and the Director has reasonable grounds to believe that, if the source of contaminant is considered, a discharge of the relevant contaminant may cause an adverse effect.

(3) Before the Director gives a person a notice under subsection (2), the Director shall give the person a draft of the notice and an opportunity to make written submissions to the Director during the period that ends 30 days after the draft is given."

A series of conservative modelling dispersion factors (in micrograms per cubic metre per gram per second emission) have been developed for a short stack on a 6 metre tall building in combination with distances from the stack as shown in Table 3.1. In most cases, if the aggregate facility-wide emissions of a contaminant multiplied by the appropriate dispersion factor from Table 3.1 is less than the MOE POI Limit, then the assessment for that contaminant should be complete. Conversion factors can be used to convert the 1 hour SCREEN3 model outputs for comparison to MOE POI Limits with different averaging times in accordance with section 17 of the Regulation. A proponent may assess the ground level concentrations using this conservative method, and, if the modelled concentrations meet the limits, the proponent is likely to meet the MOE POI Limits for the appropriate averaging times.

Table 3-1: Conservative Dispersion Factors (1 hour averaging time period)

Distance (m)	Urban Dispersion Factor ($\mu g/m^3$ per g/s emission)	Rural Dispersion Factor ($\mu g/m^3$ per g/s emission)
20	8700	10000
40	6300	8100
60	4600	5900
80	3400	5100
100	2600	4500
150	1400	3500
200	900	2800
250	600	2300
300	450	1900
350	350	1700
400	300	1500
450	250	1300
500	200	1150
600	150	950
700	120	800
800	90	650
900	80	575
1000	70	500

This Table contains three columns and one header row. The first column contains the distance from the source, and the remaining two columns contain the corresponding Dispersion Factor. The second column contains values that are to be used if modelling in urban areas, while the third column is to be used if modelling on rural areas. Chapter 5.4.2 of this guideline provides information on determining rural or urban conditions.

For cases where a facility has multiple emission sources of a contaminant, with some sources having small emission rates (i.e. negligible or insignificant sources), the sum of the emissions from the insignificant sources may be multiplied by the appropriate dispersion factor. The resulting concentration for the negligible or insignificant sources shall be added to the SCREEN3 (or Tier 2 or 3) model results performed for the more significant sources of that contaminant to assess whether or not the MOE POI Limits are met.

3.1.2 Modelling Multiple Sources Using SCREEN3

SCREEN3 performs single source calculations to determine maximum 1 hour average concentrations downwind of the source. SCREEN3 can be applied to multi-source facilities by conservatively summing the maximum concentrations for the individual emission sources. As newer models (e.g. AERSCREEN) are introduced by the US EPA and adopted by the MOE, screening assessments for multiple emission sources will be possible.

To simplify the modelling when there are many release points on a facility, a proponent may choose to:

i. combine individual stacks/vents into a single stack where the stack parameters are selected to generate a conservative dispersion factor; or

ii. combine individual sources into area or volume sources where the size and locations of the sources are conservatively selected.

Information on which sources can be grouped and how this can be done conservatively is given in Chapter 4.5.2. The approach of combining sources may also be used in Tier 2 and Tier 3 modelling as long as the source characteristics selected are reasonably conservative.

3.1.3 Use of Screening-Level Meteorological Data

For cases where a facility has multiple emission sources of a contaminant, and the combining of sources for use with SCREEN3 is too conservative, the ISCPRIME model may be used in combination with an MOE-prepared screening-level meteorological data set that incorporates the full range of wind directions and meteorological conditions. This meteorological data set is available from the MOE (EMRB) upon request, and contains fewer data points than the regional meteorological data sets to minimize model run times.

3.2 Tier 2 Modelling

Tier 2 assessments involve the use of the more advanced approved US EPA models, such as AERMOD and ISCPRIME, and the use of regional meteorological data sets made available by the MOE. MOE has created the regional meteorological data sets to be used in these assessments, which are available on the MOE website at www.ene.gov.on.ca/envision/air/regulations/metdata/met.htm. Alternately, the meteorological data sets may also be obtained through the Ministry of the Environment's Public Information Centre: 1st floor, 135 St. Clair Avenue West, Toronto, ON M4V 1P5, 416-325-4000, 1-800-565-4923.

This is consistent with subsection 13(1) of the Regulation (for more information on meteorological data, see Chapter 6 of this guideline).

The available files include the final AERMOD-ready regional data files in addition to the AERMET-ready surface and upper air files. Local land use conditions can be incorporated by using the surface and upper air files in AERMET to produce model-ready files. Data sets for ISCPRIME are also available. The dispersion modelling assessment should be completed with the most appropriate regional data set for the location of the facility and compared to MOE POI Limits for the appropriate averaging period to demonstrate compliance.

Note: As set out in subsection 13(1) paragraph 2, it is possible to refine regional meteorological data sets by specifying local land use conditions when using AERMOD. This step would still be considered a part of a Tier 2 assessment, however, the model inputs must be clearly articulated and documented in the Emission Summary and Dispersion Modelling Report (ESDM Reports) (see Chapter 10.1.1 of the ESDM Procedure Document and subsection 26(1), paragraph 10 of the Regulation).

3.3 Tier 3 Modelling

For situations where compliance has not been demonstrated in a Tier 2 assessment, or the regional meteorological data set is not representative of the conditions at the facility being modelled, more precise analysis with locally representative meteorological data or advanced modelling (Tier 3) shall be used to assess contaminant concentrations. Alternative models may be required under section 7 of the Regulation. A Tier 3 assessment would consider the use of alternative models if approved by MOE. Subsections 13(1) paragraphs 3 and 4 also set out the requirements for more site specific meteorological data and subsections 13(2) and 13(3) set out a notice provision where the Director may specify the type of meteorological data to be used. For more information, see Chapter 6 of this guideline.

For some geographical locations with unique local meteorology, appropriate local meteorological data sets may be obtained from the MOE. The proponent should verify with the MOE whether such meteorological data is available and appropriate for the facility being modelled. For other locations, local meteorological data would be developed by the proponent and agreed to by the MOE. Where the proponent wishes to apply more site-specific meteorological data, two options are available:

- Using standard Environment Canada hourly observations for a representative location in the vicinity of the facility (converted to imperial units and reformatted into a format acceptable to AERMET or PCRAMMET), and upper air data as available from the MOE, the proponent would process the data through AERMET or PCRAMMET to produce the meteorological input files. Pre-approval of the prepared meteorological input files by the MOE is required prior to modelling. Chapter 6.5 describes the information needed for verifying the meteorological data files produced by a proponent.

- Using on-site data or advanced meteorological modelling, the proponent would prepare more detailed and site-specific data files. In this case, a plan would be submitted to the MOE, and upon approval the meteorological data set and supporting documentation would be submitted to the MOE for review.

In either case, the modelling **shall not** commence until the MOE approval of the data and modelling plan is granted under s.13 of the Regulation. A form is available on the MOE website to request approval of site specific meteorological data

[“Request for Approval under s.13(1) of Regulation 419/05 for use of site specific meteorological data” (PIBs # 5350e)].

The Tier 2 and Tier 3 modelling assessments calculate each hour of the meteorological data set, which allows for specifying emission rates appropriate to the hour of day and day of week both for assessing concentrations over effects based MOE POI Limits and their respective averaging time periods.

4.0 MODEL INPUT DATA

Emission rate estimates are a key input parameter for the use of an approved dispersion model. Section 10 of the Regulation relates to facility operating conditions. Section 11 sets out the requirements for emission rates. Section 12 sets out the requirements to either "refine" emission estimates or mitigate air pollution when the combined effect of Sections 10 and 11 indicate exceedences of air quality standards (or MOE POI Limits). The ESDM Procedure Document provides guidance on estimating emission rates to ensure that assessments of maximum point of impingement concentration are as accurate as possible and do not under-estimate actual concentrations.

Chapters 4 through 7 of the ADMGO document provide guidance on the model input parameter requirements within sections 13 through 17 of the Regulation.

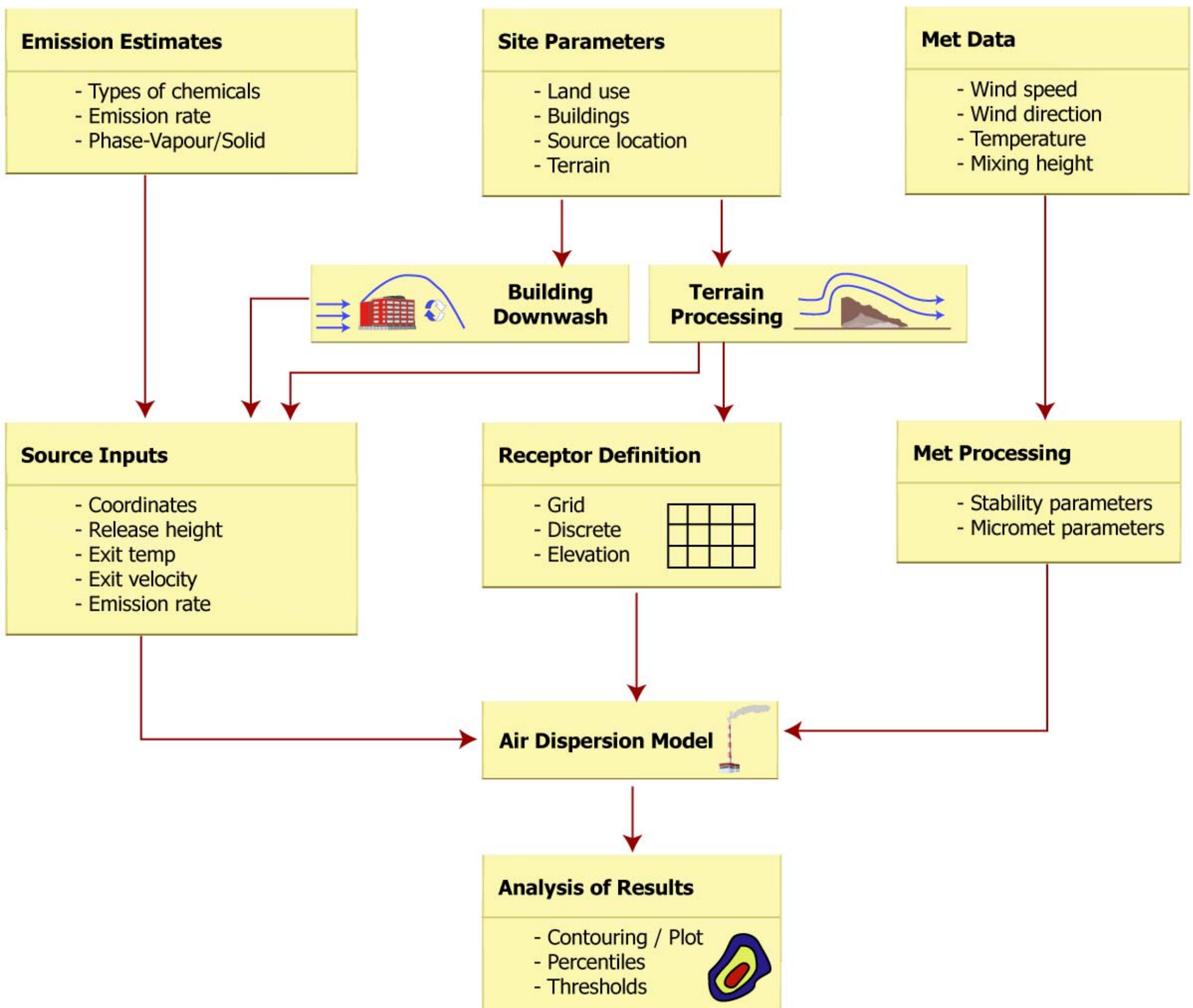
4.1 Comparison of Screening and Other Approved Model Requirements

Screening model requirements are the least intensive but produce the most conservative results. The SCREEN3 model has straight-forward input requirements and is further described in Chapter 4.1.1.

Air dispersion modelling using the US EPA models AERMOD or ISCPRIME can be broken down into a series of steps. These are described in Chapters 4.1.2 and 4.1.3.

A general overview of the process typically followed for performing an air dispersion modelling assessment is presented in Figure 4.1: Generalized process for performing an air dispersion modelling assessment. The figure is not meant to be exhaustive in all data elements, but rather provides a picture of the major steps involved in an assessment.

Figure 4.1: Generalized Process Flow Diagram for Performing an Air Dispersion Modelling Assessment.



4.1.1 SCREEN3 Air Dispersion Modelling

The SCREEN3 model[12] was developed to provide an easy-to-use method of obtaining contaminant concentration estimates. To perform a modelling study using SCREEN3, data for the following input requirements shall be supplied:

- *Source Type* (Point, Flare, Area or Volume)
- Physical Source and Emissions Characteristics. For example, a point source requires:
    - Emission Rate
    - Stack Height

    - Stack Inside Diameter
    - Stack Gas Exit Velocity
    - Stack Gas Exit Temperature
    - Ambient Air Temperature
    - Receptor Height Above Ground

- *Meteorology*: Although no data input is required, SCREEN3 provides users with the option to consider all wind speeds and stability classes, or a specific stability class and wind speed can be provided.

- *Building Downwash*: If this option is used then building dimensions (height, length and width) must be specified.

- *Terrain*: SCREEN3 supports flat, elevated and complex terrain. If elevated or complex terrain is used, distance and terrain heights must be provided.

- *Fumigation*: SCREEN3 supports shoreline fumigation. If used, distance to shoreline must be provided.

As can be seen above, the input requirements are minimal to perform a screening analysis using SCREEN3. This model is normally used as an initial screening tool to assess single sources of emissions. SCREEN3 can be applied to multi-source facilities by conservatively summing the maximum concentrations for the individual emissions sources. The models discussed in the following sections, have much more detailed options allowing for greater characterization and more representative results.

4.1.2 AERMOD Air Dispersion Modelling

The more advanced approved models have many input options, and are described further throughout this document as well as in their own respective technical documents[1,4,5,9,10]. An overview of the modelling approach and general steps for using models such as AERMOD and ISCPRIME are provided below. The general process for performing an air dispersion study using AERMOD includes:

- Process meteorological data using AERMET.

- Obtain digital terrain elevation data (if terrain is being considered – see section 16 of the Regulation).

- Incorporate building downwash using BPIP-PRIME (requires source and building information).

- Characterize site – complete source and receptor information.

- Perform terrain data pre-processing (if required) for AERMOD dispersion model using AERMAP.

- Run the model.

- Visualize and analyze results.

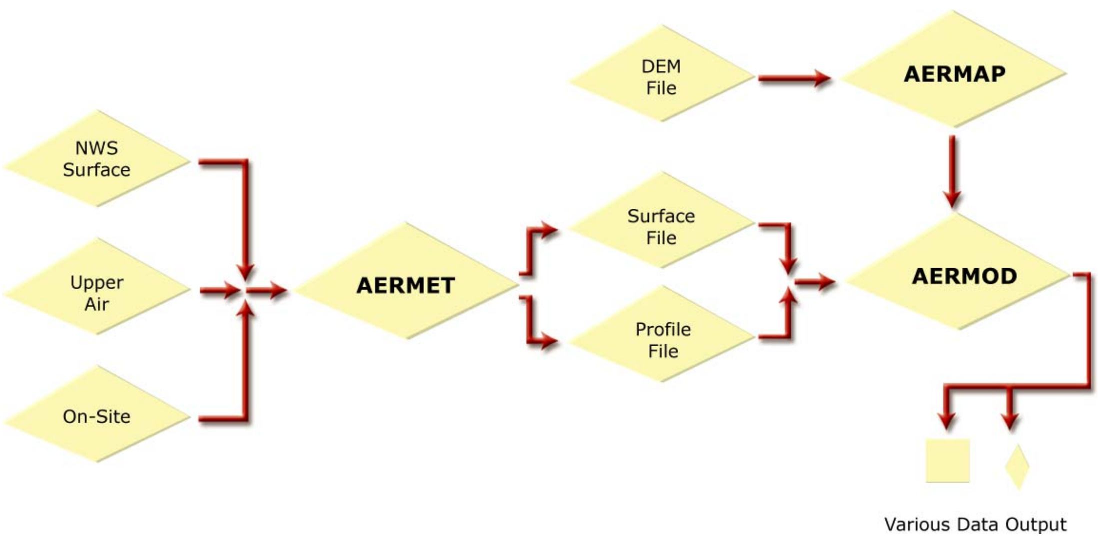
As can be seen above, the AERMOD modelling system is comprised of three primary components as outlined below and illustrated in Figure 4.2:

1. AERMET – Meteorological Data Pre-processor

2. AERMAP – Digital Terrain Pre-processor

3. AERMOD – Air dispersion model

Figure 4.2: AERMOD Air Dispersion Modelling System



To successfully perform a complex terrain air dispersion modelling analysis using AERMOD, a proponent must complete the processing steps required by AERMET and AERMAP. See Chapter 6.3 for more information on meteorological data.

4.1.3 ISCPRIME Air Dispersion Modelling

ISCPRIME has very similar input requirements when compared with AERMOD. Input requirements for ISCPRIME include:

- Process meteorological data using PCRAMMET.

- Obtain digital terrain elevation data (if terrain is being considered – see section 16 of the Regulation).

- Incorporate building downwash using BPIP-PRIME – requires source and building information.
- Characterize site - complete source and receptor information.
- Run the chosen model.
- Visualize and analyze results.

As can be seen above, the ISCPRIME and AERMOD models follow a very similar approach to performing an air dispersion modelling project. The primary difference in running ISCPRIME and AERMOD models is that ISCPRIME does not have a terrain pre-processor, such as AERMAP; therefore requiring the terrain data to be incorporated using other methodologies. Furthermore, ISCPRIME relies on a different meteorological pre-processor known as PCRAMMET. The components of meteorological data pre-processing using PCRAMMET are illustrated in Figure 4.3 below. For a complete outline on how to obtain Ontario meteorological data and its processing requirements, please see Chapter 6.3.

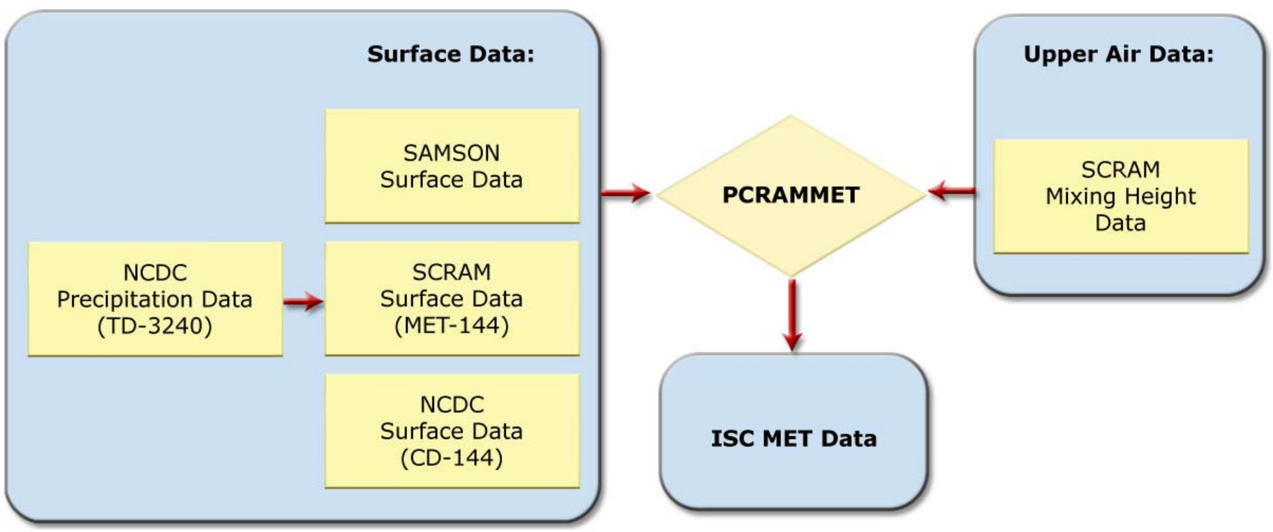


Figure 4.3: Meteorological Data Pre-Processing Flow Diagram for ISCPRIME

4.2 “Regulatory” and “Non-Regulatory” Option Use

The ISCPRIME and AERMOD models contain several options, which are set by default, that have been identified by the US EPA as “regulatory options”[7]. The models also include non-regulatory options. Depending on the model, the non-regulatory options can include:

- No stack-tip downwash (NOSTD);
- Missing data processing routine (MSGPRO);
- Bypass the calms processing routine (NOCALM);
- Gradual plume rise (GRDRIS);
- No buoyancy-induced dispersion (NOBID);
- Air Toxics Options (TOXICS);
- By-pass date checking for non-sequential met data file (NOCHKD) (AERMOD);
- Deposition (WET, DRY);
- Conversion of NO_x to NO_2 (two methods OLM and PVMRM); and
- Flat terrain (FLAT) (AERMOD)
- Plume Depletion

Proponents shall use all default regulatory options in performing their modelling assessments. Selected non-regulatory options may be used in a Tier 2 assessment, but only for side vents and horizontal caps (see Chapter 4.5.3.2 Horizontal Sources and Rain Caps).

The MOE may consider whether it is appropriate to use deposition and plume depletion for Tier 3 modelling assessments, such as those requested for approval under paragraph 3 of s.11(1) of the Regulation for a combined analysis of modelled and monitoring results. Other non-regulatory options may also be considered in a Tier 3 assessment, subject to MOE approval. In such circumstances, proponents shall obtain MOE (EMRB) approval for the use of non-regulatory options before

7 **Note:** For the purposes of this ADMGO document, the terms “regulatory options” and “non-regulatory” options refer to the US EPA nomenclature of defining various aspects of the dispersion models and do not necessarily refer to requirements within the Regulation.

submitting their modelling results to the MOE. Proponents are strongly encouraged to consult with the MOE in advance of conducting their model runs.

4.3 Coordinate System

Any modelling assessment will require a coordinate system be defined in order to assess the relative distances from sources and receptors and, where necessary, to consider other geographical features. Employing a standard coordinate system for all projects increases the efficiency of the review process while providing real-world information of the site location. AERMOD's terrain pre-processor, AERMAP, requires digital terrain in Universal Transverse Mercator (UTM) coordinates. The UTM system uses metres as is its basic unit of measurement and allows for more precise definition of specific locations than latitude/longitude.

For more information on coordinate systems and geographical information inputs, see Chapter 5.0.

4.4 Averaging Periods (Conversion Factor)

MOE POI Limits are expressed over certain averaging time periods. As specified in section 17 of the Regulation, where a dispersion model is designed to determine a concentration for the specified averaging period, it shall be used as it was designed.

When a dispersion model which can only calculate concentrations for either one or a limited range of averaging time periods is used, conversion factors can be applied to estimate likely maximum concentrations over other averaging time periods. The conversion allows screening assessments of model results against MOE POI limits with their respective averaging time periods. Models such as AERMOD and ISCPRIME provide the capability of providing 1, 2, 3, 4, 6, 8, 12, and 24 hr averages, as well as monthly, therefore eliminating the need for conversion factors within these averaging time periods. The need for conversion factors, however, is still required when modelling for averaging time periods less than one hour. For example, for contaminants where the MOE POI Limit is based on a 30 minute averaging time period, only the 1 hour averaging time period results obtained from the model can be converted to a 30 minute averaging time period (see subsection 17(1)(3) of the Regulation).

Section 17 of the Regulation specifies averaging periods to be used and when and how conversion of averaging periods can occur, as follows:

Averaging periods

"17. (1) If a provision of this Part refers to an approved dispersion model being used in connection with a standard that applies to a specified averaging period, the following rules apply for the purposes of this Part:

1. ***If an approved dispersion model was designed to be used for the specified averaging period, it shall be used as it was designed for that averaging period.***

2. ***If an approved dispersion model was not designed to be used for the specified averaging period but was designed to be used for an averaging period shorter than the specified averaging period, the model may be used as it was designed for the shorter averaging period if the result produced by the model is adjusted in accordance with subsection (2).***

3. ***If the specified averaging period is less than one hour and an approved dispersion model was designed to be used for a one hour period, the model may be used as it was designed for a one hour period if the result produced by the model is adjusted in accordance with subsection (2).***

4. ***If the use of an approved dispersion model is not authorized or required by paragraph 1, 2 or 3, the model shall not be used.***

(2) If a provision of this Part refers to an approved dispersion model being used in connection with a standard that applies to a specified averaging period,

(a) the result produced by the approved dispersion model shall be multiplied by the amount determined in accordance with subsection (3), if the model is used under paragraph 2 of subsection (1); and

(b) the result produced by the approved dispersion model shall be divided by the amount determined in accordance with subsection (3), if the model is used under paragraph 3 of subsection (1).

(3) The amount referred to in clauses (2) (a) and (b) is the amount determined in accordance with the following formula:

$$(t_0 \div t_1)^n$$

where,

t_0 = the shorter of,

i. the averaging period that the approved dispersion model was designed to be used for, expressed in hours, and

ii. the specified averaging period, expressed in hours,

t_1 = the longer of,

i. the averaging period that the approved dispersion model was designed to be used for, expressed in hours, and

ii. the specified averaging period, expressed in hours,

n = 0.28 or, if the Director is satisfied that another number would result in an adjustment that produces a more accurate prediction of the concentration of the relevant contaminant, the other number.

(4) If an approved dispersion model is used with respect to a person and contaminant to whom section 20 applies and Schedule 3 sets out more than one standard for the contaminant, using different averaging periods, the model shall be used with respect to each averaging period.

(5) This section does not apply if,

(a) The approved dispersion model that is used is the ASHRAE method of calculation and the model is being used in connection with a standard set out in Schedule 3 that applies to a 10 minute averaging period; or

(b) The approved dispersion model that is used is the method of calculation required by the Appendix to Regulation 346.

A range of averaging time conversion factors have been used in various studies. The equation given below is consistent with subsections 17(2) and 17(3) of the Regulation and allows conversion factors to be calculated as a function of the atmospheric stability class. Where necessary, the equation allows stability dependent conversion factors through variation of the numerical value of the exponent n[8].

Equation 1:

$$C_0 = C_1 \times F$$

where,

C_0 = the concentration at the averaging period t_0

C_1 = the concentration at the averaging period t_1

F = factor to convert from the averaging period t_1 to the averaging period t_0

$= (t_1/t_0)^n$

and where, $n = 0.28$

The formula could be used to calculate shorter averaging time concentrations such as a 10 minute MOE POI Limit starting from a modelled one hour average concentration. The equations can also be used to estimate a likely maximum 24 hour average concentration from a model that only produces 1-hour results. For example, output from SCREEN3 could be converted as follows:

$$C_{24\ hr} = C_{1\ hr} \times (1\ hr/24\ hr)^n$$

where: $C_{1\ hr}$ and $C_{24\ hr}$ are the maximum average concentrations respectively.

[8] Considering the modelling limitations and with a goal to reduce the complexity for proponents, the MOE is retaining the historical power exponent of n = 0.28 for conversion. A proponent or the MOE may, in special situations, demonstrate that the use of an alternative conversion approach may be more appropriate or required (see s.17(3) of the Regulation).

The following table (Table 4-1) lists some of the conversions that may be required by proponents to compare modelled results to MOE POI Limits.

Table 4-1: Common Averaging Time Conversion Factors

To Convert From:	Convert To:	Multiply by:
1hr	10 min	1.65
1hr	½ hr	1.2
1hr	24hr	0.4

This Table contains three columns and one row header. The first column contains the averaging period to be converted from, and the second column contains the averaging period to be converted to, and the third column contains the corresponding conversion multiplication factor.

4.5 Defining Source Types

4.5.1 Selection, Description and Parameters

SCREEN3, ISCPRIME and AERMOD support a variety of source types that can be used to characterize most emissions within a study area. Primary source types and their input requirements for both screening and the more advanced models are discussed below. Detailed descriptions on the input fields for these models can be found in the corresponding US EPA model User's Guides, which are referenced in Chapter 10, and are for SCREEN3 in US EPA(12), for ISCPRIME in US EPA(4,9); and for AERMOD(1).

Point Sources

Point sources are typically used to model releases from sources like stacks and isolated vents. Input requirements for point sources include:

SCREEN3

- **Emission Rate:** The emission rate of the contaminant.
- **Stack Height:** The stack height above ground.
- **Stack Inside Diameter:** The inner diameter of the stack.
- **Stack Gas Exit Velocity [m/s] or Stack Gas Exit Flow Rate [m³/s]:** Either the stack gas exit velocity or the stack gas exit flow rate must be given. The exit velocity can be determined from the following formula:

$$V_s = \frac{4V}{\pi d_s^2}$$

V_s = Exit Velocity

V = Flow Rate

d_s = Stack Inside Diameter

- **Stack Gas Temperature:** The temperature of the released gas in degrees Kelvin (K).

- **Ambient Air Temperature:** The average atmospheric temperature (K) in the vicinity of the source. If no ambient temperature data are available, assume a default value of 293 degrees K. For non-buoyant releases, the user shall input the same value for the stack temperature and ambient temperature.

- **Receptor Height above Ground:** This shall be used to model impacts at “flagpole” receptors. A flagpole receptor is defined as any receptor located above ground level, e.g., to represent the roof or balcony of a building. The default value is assumed to be 0.0 m (i.e., ground-level receptors).

Urban/Rural Option: Specify either Urban or Rural conditions to use the appropriate dispersion coefficient. Chapter 5.4.5 provides guidance on determining rural or urban conditions.

AERMOD/ISCPRIME

- **Source ID:** An identification name for the source being defined, up to 8 characters in length.

- **X Coordinate:** The x (east-west) coordinate for the source location in metres (centre of the point source).

- **Y Coordinate:** Enter here the y (north-south) coordinate for the source location in metres (centre of the point source).

- **Base Elevation:** The elevation of the base of the source. The model only uses the source base elevation if **Elevated** terrain is being used.

- **Release Height above Ground:** The source release height above the ground in metres.

- **Emission Rate:** The emission rate of the contaminant in grams per second.

- **Stack Gas Exit Temperature:** The temperature of the released gas in degrees Kelvin.

- **Stack Gas Exit Velocity:** The stack gas exit velocity in metres per second or the stack gas flow rate (see above Chapter on SCREEN3).

- **Stack Inside Diameter:** The inner diameter of the stack.

Area Sources

Area sources are used to model low level or ground level releases where releases occur over an area (e.g., landfills, storage piles, slag dumps, and lagoons). SCREEN3 allows definition of a rectangular area while the ISCPRIME and AERMOD models accept rectangular areas that may also have a rotation angle specified relative to a north-south orientation. AERMOD can also handle circular and polygon shapes.

SCREEN3

- **Emission Rate:** The emission rate of the contaminant. The emission rate for area sources is entered as an emission rate per unit area ($g/(s\text{-}m^2)$).

- **Source Release Height:** The source release height above ground.

- **Larger Side Length of Rectangular Area:** The larger side of the rectangular source in metres.

- **Smaller Side Length of Rectangular Area:** The smaller side of the rectangular source in metres.

- **Receptor Height above Ground [m]:** This shall be used to model impacts at "flagpole" receptors. A flagpole receptor is defined as any receptor that is located above ground level, e.g., to represent the roof or balcony of a building. The default value is assumed to be 0.0 m (i.e., ground-level receptors).

- **Wind Direction Search Option:** Since the concentration at a particular distance downwind from a rectangular area is dependent on the orientation of the area relative to the wind direction, the SCREEN model provides the user with two options for treating wind direction. The proponent shall use the regulatory default option ("YES") which results in a search of a range of wind directions. See US EPA[15] for more detailed information.

AERMOD/ISCPRIME

- **Source ID:** An identification name for the source being defined, up to 8 characters in length.

- **X Coordinate:** The x (east-west) coordinate for the vertex (corner) of the area source that occurs in the southwest quadrant of the source. Units are in metres.

- **Y Coordinate:** The y (north-south) coordinate for the vertex (corner) of the area source that occurs in the southwest quadrant of the source. Units are in metres.

- **Base Elevation:** The elevation of the base of the source. The model only uses the source base elevation if elevated terrain is being used. The default unit is metres.

- **Release Height above Ground [m]:** The release height above ground in metres.

- **Emission Rate [g/(s-m^2)]:** Enter the emission rate of the contaminant. The emission rate for Area sources is entered as an emission rate per unit area. The same emission rate is used for both concentration and deposition calculations.

- **Options for Defining Area:** In ISCPRIME the only option for defining the area is a rectangle. The maximum length/width aspect ratio for area sources is 10 to 1. If this is exceeded, then the area shall be divided to achieve a 10 to 1 aspect ratio (or less) for all sub-areas. See US EPA(4) for more details on entering area data. In addition to the rectangular area, AERMOD can have circular or polygon areas defined (see US EPA(1) for details).

Note: There are no restrictions on the location of receptors relative to area sources. Receptors may be placed within the area and at the edge of an area. ISCPRIME and AERMOD will integrate over the portion of the area that is upwind of the receptor. The numerical integration is not performed for portions of the area that are closer than 1.0 metre upwind of the receptor. Therefore, caution should be used when placing receptors within or adjacent to areas that are less than a few metres wide. In such cases, proponents are encouraged to contact MOE (EMRB) to discuss receptor placement.

Volume Sources

Volume sources are used to model releases from a variety of industrial sources, such as building roof monitors, fugitive leaks from an industrial facility, multiple vents, and stacker drop points.

SCREEN3

- **Emission Rate:** The emission rate of the contaminant in grams per second (g/s).

- **Source Release Height:** The source release height above ground surface.

- **Initial Lateral Dimension:** See Table 4-2 for guidance on determining initial dimensions. Units are metres.

- **Initial Vertical Dimension:** See Table 4-3 for guidance on determining initial dimensions. Units are metres.

- **Receptor Height above Ground [m]:** This shall be used to model impacts at “flagpole” receptors. A flagpole receptor is defined as any receptor which is located above ground level, e.g., to represent the roof or balcony of a building. The default value is assumed to be 0.0 m (i.e., ground-level receptors).

Table 4-2: Estimation of Initial Lateral Dimension (s_{yo}) for Volume and Line Sources

Type of Source	Procedure for Obtaining Initial Dimension
Single Volume Source	$s_{yo} = \frac{\text{side length}}{4.3}$
Line Source Represented by Adjacent Volume Sources	$s_{yo} = \frac{\text{side length}}{2.15}$
Line Source Represented by Separated Volume Sources	$s_{yo} = \frac{\text{centre to centre distance}}{2.15}$

This Table contains two columns and one header row. The first column lists the Type of Source, and the second lists the corresponding equation to be used.

Source: U.S. Environmental Protection Agency, 1995 User’s Guide for the Industrial Source Complex (ISCST3) Dispersion Models - Volume I, EPA-454/B-95-003a. U.S. Environmental Protection Agency. Research Triangle Park, NC 27711.

Table 4-3: Estimation of Initial Vertical Dimension (s_{zo}) for Volume and Line Sources

Type of Source	Procedure for Obtaining Initial Dimension
Surface-Based Source ($h_e \sim 0$)	$s_{zo} = \frac{\text{vertical dimension of source}}{2.15}$
Elevated Source ($h_e > 0$) on or Adjacent to a Building	$s_{zo} = \frac{\text{building height}}{2.15}$
Elevated Source ($h_e > 0$) not on or Adjacent to a Building	$s_{zo} = \frac{\text{vertical dimension of source}}{4.3}$

Note: h_e is release height

This Table contains two columns and one header row. The first column lists the Type of Source, and the second lists the corresponding equation to be used.

Source: U.S. Environmental Protection Agency, 1995 User’s Guide for the Industrial Source Complex (ISCST3) Dispersion Models - Volume I, EPA-454/B-95-003a. U.S. Environmental Protection Agency. Research Triangle Park, NC 27711.

AERMOD/ISCPRIME

- **Source ID:** An identification name for the source being defined, up to 8 characters in length.
- **X Coordinate:** The x (east-west) coordinate for the source location in metres. This location is the centre of the volume source.
- **Y Coordinate:** The y (north-south) coordinate for the source location in metres. This location is the centre of the volume source.
- **Base Elevation:** The elevation of the base of the source. The model only uses the source base elevation if elevated terrain is being used. The default unit is metres.
- **Release Height above Ground:** The release height above ground surface in metres (centre of volume).
- **Emission Rate [g/s]:** The emission rate of the contaminant in grams per second. The same emission rate is used for both concentration and deposition calculations.
- **Length of Side:** The length of the side of the volume source in metres. The volume source cannot be rotated and has the X side equal to the Y side (square).
- **Building Height (If On or Adjacent to a Building):** If the volume source is elevated and is on or adjacent to a building, then the proponent needs to specify the building height. The building height can be used to calculate the Initial Vertical Dimension of the source. Note that if the source is surface-based, then this is not applicable.
- **Initial Lateral Dimension [m]:** This parameter is calculated by choosing the appropriate condition in Table 4-2 above. This table provides guidance on determining initial dimensions. Units are in metres.
- **Initial Vertical Dimension [m]:** This parameter is calculated by choosing the appropriate condition in Table 4-3 above. This table provides guidance on determining initial dimensions. Units are in metres.

Line Sources

Examples of line sources are conveyor belts and rail lines. SCREEN3, AERMOD and ISCPRIME do not have a default line source type. However, ISCPRIME and AERMOD can simulate line sources through a series of volume sources. If a facility contains line sources, the proponent shall follow the methodology outlined in the

"Line Source Represented by Separated Volume Sources" as described in Volume II of the *U.S. EPA User's Guide for the Industrial Source Complex (ISCST3) Dispersion Models*(5).

For consideration of traffic related contaminants, a traffic air dispersion model such as CAL3QHCR or CALINE4 may need to be considered. Further details on these models can be found in *Appendix A: Alternative Models*.

Open Flare Sources

Flare sources are used as control devices for a variety of sources. Enclosed flares are typically modelled as normal point sources when using SCREEN3, ISCPRIME or AERMOD. Due to their unique characteristics, open flares must be modelled differently. SCREEN3 supports open flares directly through its flare source type. ISCPRIME and AERMOD do not have a specific source type option for flare sources, but the method described below shall be applied to model flares in ISCPRIME or AERMOD.

SCREEN3

- **Emission Rate:** The emission rate of the contaminant in grams per second (g/s).

- **Flare Stack Height:** The stack height above ground (m).

- **Total Heat Release Rate:** The heat release rate in calories per second (cal/s) for the flare.

- **Receptor Height above Ground:** This shall be used to model impacts at "flagpole" receptors. A flagpole receptor is defined as any receptor which is located above ground level, e.g., to represent the roof or balcony of a building. The default value is assumed to be 0.0 m (i.e., ground-level receptors).

Note 1: US EPA's SCREEN3 model calculates plume rise for flares based on an effective buoyancy flux parameter. An ambient temperature of 293K is assumed in this calculation and therefore no ambient temperature is entered by the user. It is assumed that 55% of the total heat is lost due to radiation. Plume rise is calculated from the top of the flame, assuming that the flame is bent 45 degrees from the vertical. SCREEN3 calculates and prints out the effective release height for the flare.

Note 2: For Flare releases, EPA's SCREEN3 model assumes a stack gas exit velocity (V_s) of 20 m/s, an effective stack gas exit temperature (T_s) of 1,273K, and calculates an effective stack diameter based on the heat release rate.

AERMOD/ISCPRIME

Flare sources can be modelled similar to point sources, except that there are buoyancy flux reductions associated with radiative heat losses that must be considered, and a need to account for the flame length in estimating plume height(14.15). Input requirements are similar to those for a point source, except that the release height must be calculated as an effective release height and stack parameters need to be estimated to match the radiative loss reduced buoyancy flux.

Due to the high temperature associated with flares, the effective release height of the plume shall be calculated as follows(15):

$$H_{sl} = H_s + 4.56 \times 10^{-3} \bullet \left(\frac{H_r}{4.1868} \right)^{0.478} \qquad \text{(m)}$$

where:

H_{sl} = effective flare height (m)

H_s = stack height above ground (m)

H_r = net heat release rate (Joules per sec, J/s)

Calculation of the net heat release rate is generally based on the method outlined in EPA guidance(15), and is computed as follows:

$$H_r = \dot{m} \bullet \sum_{i=1}^{n} f_i H_i \bullet (1 - F_r)$$

where:

$\dot{m}$ = total molar flow rate to the flare (g-mole/s)

f_i = mole fraction or volume fraction of each gas component

H_i = net heating value of each component (J/g-mole)

F_r = fraction of radiative heat loss

It should be noted that the total molar flow rate to the flare must include all compounds that liberate heat during combustion, and may contain other compounds such as water, oxygen, carbon dioxide, etc. However, inclusion of these additional compounds is not necessary provided that the mole fraction calculations are done

on the same basis (i.e. all those considered in the total molar flow rate are considered in the fraction calculations and sum to 1).

The fraction of radiative heat loss depends on the burning conditions of the flare. If there is information specific to the flare, then that fractional loss shall be used. As a default, a heat loss of 25% shall be used, as recommended by Alberta Environment(16).

The stack parameters can be estimated by matching the buoyancy flux from the flare. The buoyancy flux from the flare, in m^4/s^3 is:

$$F = \frac{g \bullet H_r}{\pi \bullet \rho \bullet T \bullet C_p}$$

where:

g	=	acceleration due to gravity (m/s^2)
ρ	=	density of air (kg/m^3)
T	=	air temperature (°K)
C_p	=	specific heat of dry air constant (J/(Kg °K)

Assuming a temperature of 0°C,

ρ	=	1.29 (kg/m^3)
T	=	273 (°K)
C_p	=	1003 (J/(Kg °K)

Therefore;

$$F = \left(8.8 \times 10^{-6}\right) \bullet H_r$$

Buoyancy flux for stack releases is:

$$F = g \bullet V_s \bullet r_s^2 \bullet \left(\frac{T_s - T}{T_s}\right)$$

where:

V_s	=	exit velocity (m/s)
r_s	=	stack inner radius (m)
T_s	=	stack exit temperature (°K)

Using an estimated stack gas exit temperature (1,273 °K is used in SCREEN3) and the actual exit velocity to the flare, an effective stack radius shall be calculated for input to AERMOD and ISCPRIME to model flare sources.

4.5.2 Combining Individual Sources into Volume, Area and Single Point Sources

There are cases where a facility could have a number of release points from vents and short stacks in a confined area at the facility. To simplify the modelling when there are many release points, a proponent may conservatively combine these stacks/vents into a volume source, an area source or a single point source.

The following factors shall be considered when selecting potential sources for combination into a single source:

(a) The source characteristics of the individual stacks or vents must be similar.

iii. The emission rates from the individual release points must be similar (i.e. there are not one or two sources with significantly larger emission rates).

iv. The sources must be located over an area or volume that can be reasonably well defined.

v. The property line must not be too far from the group of stacks/vents.

The choices of size and location of volume or area sources or the stack parameters for a single stack representing a group shall be selected conservatively. For

example, the parameters for the single stack shall not result in larger plume rise than would have occurred for the large majority of the stacks being combined. The relative emission rates from the combined stacks may also be considered in selecting stack parameters. Proponents are encouraged to contact EMRB for specific guidance in these situations.

Output of Results for Groups of Sources

When modelling is performed for a number of individual stacks, volume sources or area sources, source groups enable modelling results to be output for specific combinations of sources. The default in AERMOD and ISCPRIME is the creation of source group "ALL" that considers all the sources at the same time. Analysis of specific groups of sources, such as process vents, site roadways, combustion equipment, etc, can be performed by using the SRCGROUP option. Conversely, individual sources may be assigned to a separate group to determine the concentrations generated by each individual source. It should be noted however that when this is done for individual sources or groups the results reflect the maximum predicted concentrations from each of these, rather than the contribution to the overall maximum from all sources.

4.5.3 Special Considerations

During some air quality studies, certain source configurations may be encountered that require special attention. Some examples include horizontal sources or emissions from storage tanks. The following Chapters outline modelling techniques on how to account for the special characteristics of such scenarios.

Multiple Stacks

When the plumes from multiple closely-spaced stacks or flues merge, the plume rise can be enhanced. Briggs(17) has proposed equations to account for this. The reader is referred to that document for further details. Most models do not explicitly account for enhanced plume rise from this cause, and most regulatory agencies do not permit it to be accounted for in regulatory applications of modelling, with one exception. That exception is the case of a single stack with multiple flues, or multiple stacks very close together (less than approximately one stack diameter apart). In these cases, the multiple plumes may be treated as a single plume. To do this, a pseudo stack diameter is used in the calculations, such that the total volume flow rate of the stack gases is correctly represented.

Horizontal Sources and Rain Caps

Both horizontal flues and vertical flues with rain caps have little or no initial vertical velocity. Plume rise calculations in most models (including AERMOD and ISCPRIME) take into account both rise due to vertical momentum of the plume as it

leaves the stack and the buoyancy of the plume. This may result in an over-prediction of the plume rise, and resulting under-prediction of ground-level concentrations, in these models.

This problem can be alleviated by modifying the source input parameters to minimize the effects of momentum while leaving the buoyant plume rise calculations unchanged. The US EPA outlines such an approach in its Model Clearinghouse Memo 93-II-09[18]. The approach is also expressed, in part, in Tikvart.[19] This approach is to reduce the stack gas exit velocity to 0.001 m/s, and calculate an equivalent diameter so that the buoyant plume rise is properly calculated. To do this, the stack diameter is specified to the model such that the volume flow rate of the gas remains correct.

In the case of horizontal flues, there will be no stack tip downwash, so that option must be turned off. In the case of vertical flues with rain caps, there will be frequent occurrences of stack tip downwash; however the effect of the stack tip downwash (reduction of the plume height by an amount up to three times the stack diameter) may be underestimated in the model. This shall be corrected, somewhat conservatively, by turning off the stack tip downwash and lowering the specification of the stack height by three times the actual stack diameter (the maximum effect of stack tip downwash). However, the modified stack height must not be reduced to be below the roof level.

With the above references in mind, it should be noted that larger diameters associated with reduced exit velocities can cause issues with the PRIME algorithm. As a result, the MOE’s approach is to use an exit velocity of 0.1 m/s, or a velocity based on limiting the exit diameter to 5 times the actual diameter up to a maximum of 5 metres. This exit velocity still effectively eliminates momentum flux and can produce parameters that will not impede model execution.

Version 06341 of AERMOD introduced an option for modelling releases from capped and horizontal discharge stacks. EPA model developers found that the Model Clearinghouse procedure is not appropriate for sources subject to building downwash influences with the PRIME downwash algorithm. The use of an effective diameter adjusted to maintain flow rate could produce unrealistic results with the PRIME algorithm. In the AERMOD capped and horizontal releases options, the vertical momentum is suppressed while the buoyancy of the plume is conserved without modifying the stack parameters.

The two new source types to be added to the SO LOCATION card are:

- POINTCAP for capped stacks, and
- POINTHOR for horizontal releases.

For each of these source types, the user must specify the actual stack parameters of release height (m), exit temperature (K), exit velocity (m/s), and stack diameter (m) using the SO SRCPARAM card as if the release were a non-capped vertical point source. The AERMOD model performs the necessary adjustments internally to account for plume rise and stack-tip downwash. For horizontal releases, the model assumes that the release is oriented with the wind direction. For PRIME-downwashed sources, the user-specified exit velocity for horizontal releases is treated initially as horizontal momentum in the downwind direction.

The capped and horizontal release option in AERMOD produces results that are very similar to those using the previously described MOE approach. The MOE requires the use of these source types when using AERMOD. However, since ISCPRIME does not support these source types, the MOE approach is to be used when using ISCPRIME. A sample step-by-step approach is as follows. In this discussion,

V = actual stack gas exit velocity

V' = stack gas exit velocity as entered into the model

D = actual stack inside diameter

D' = stack inside diameter as input to the model

H = actual stack height

H' = stack height input to the model

For the source of consideration, modify its parameters as follows:

1. Set *V'=0.1* m/s or a velocity based on limiting the exit diameter to 5 times the actual diameter up to a maximum of 5 metres
2. Set *D'*=*D**SQRT(*V/V'*)
3. If the source is a vertical stack with a rain cap, account for the frequent stack tip downwash by reducing the stack height input to the model by three times the actual stack diameter: *H'=H – 3D*

Liquid Storage Tanks

Storage tanks are generally of two types—fixed roof tanks and floating roof tanks. In the case of fixed roof tanks, most of the contaminant emissions occur from a vent, with some additional contribution from hatches and other fittings. In the case of floating roof tanks, most of the contaminant emissions occur through the seals between the roof and the wall and between the deck and the wall, with some additional emissions from fittings such as ports and hatches.

Approaches for modelling impacts from emissions from various types of storage tanks are described below.

Fixed roof tanks:

Model fixed roof tanks as a point source representing the vent, which is usually in the centre of the tank, and representing the tank itself as a building for downwash calculations.

Floating roof tanks:

Model floating roof tanks as a circle of eight (or more) point sources, representing the tank itself as a building for downwash calculations. Distribute the total emissions equally among the circle of point sources.

All tanks:

There is virtually no plume rise from tanks. Therefore, the stack parameters for the stack gas exit velocity and stack diameter shall be set to near zero for the stacks representing the emissions. In addition, stack temperature shall be set equal to the ambient temperature. This is done in ISCPRIME and AERMOD by entering a value of 0.0 for the stack gas temperature.

Note that it is very important for the diameter to be at or near zero. With low exit velocities and larger diameters, stack tip downwash will be calculated. Since all downwash effects are being calculated as building downwash, the additional stack tip downwash calculations would be inappropriate. Since the maximum stack tip downwash effect is to lower plume height by three stack diameters, a very small stack diameter effectively eliminates the stack tip downwash. Table 4-4 presents values of stack parameters used in modelling tanks.

Table 4-4: Stack Parameter Values for Modelling Tanks

Velocity	Diameter	Temperature
Near zero i.e. 0.001 m/s	Near zero i.e. 0.001m	Ambient – 0.0 sets models to use ambient temperature

This Table contains three columns and one header row. The first lists the stack Velocity, the second lists the stack Diameter, and the third lists the Temperature to be used.

4.5.4 Variable Emissions

The ISCPRIME and AERMOD models both contain support for variable emission rates. This allows for modelling of source emissions that may fluctuate over time. Emission variations can be characterized across many different periods including hourly, daily, monthly and seasonally. For more information on emission estimating, please refer to the ESDM Procedure Document.

Wind Erosion

Modelling of emissions from sources susceptible to wind erosion, such as coal piles, shall be accomplished using variable emissions.

The ISCPRIME and AERMOD models allow for emission rates to be varied by wind speed. This allows for more representative emissions from sources that are susceptible to wind erosion, particularly waste piles that can contribute to particulate emissions. Once a correlation between emissions and wind speed categories is established, the models will then vary the emissions based on the wind conditions in the meteorological data.

Non-Continuous Emissions

Sources of emissions at some locations may emit only during certain periods of time. Emissions can be varied within the ISCPRIME and AERMOD models by applying factors to different time periods.

For example, for a source that is non-continuous, a factor of 0 is entered for the periods when the source is not operating or is inactive. A factor of 0.5 decreases the mass emission rate for the selected time periods to 50%. Note that only the mass emission rate is affected with the use of these factors. The other source parameters such temperature and exit velocity remain constant. Start-ups and shutdowns are examples of non-continuous emissions which could use the variable emission rate options. Model inputs for variable emissions rates can include the following time periods:

- Hour-of-day;

- Monthly;
- Seasonally;
- Wind speed;
- By Season and hour-of-day; and
- By Season, hour-of-day, and day-of-week.

An external hourly input file can be prepared in which all parameters of a source including mass emission rate, exit velocity and temperature may be varied on an hour-by-hour basis over the entire 5-year modelling period.

4.6 Building Impacts

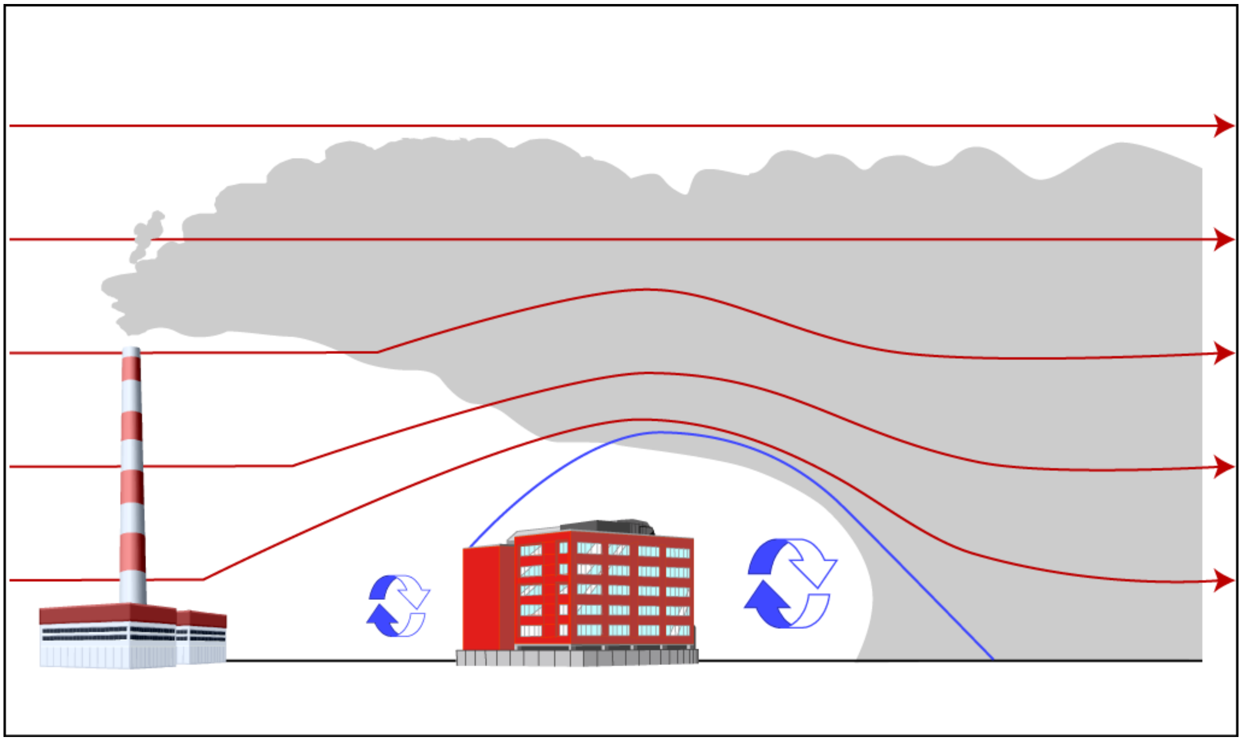
Buildings and other structures near a relatively short stack can have a substantial effect on plume transport and dispersion, and on the resulting ground-level concentrations that are observed. There has long been a generalized approach that a stack should be at least 2.5 times the height of adjacent buildings. Beyond that, much of what is known of the effects of buildings on plume transport and diffusion has been obtained from wind tunnel studies and field studies.

When the airflow meets a building (or other obstruction), it is forced up and over the building. On the lee side of the building, the flow separates, leaving a closed circulation containing lower wind speeds. Farther downwind, the air flows downward again. In addition, there is more shear and, as a result, more turbulence. This is the turbulent wake zone (see Figure 4.4).

If a plume gets caught in the cavity, very high concentrations can result. If the plume escapes the cavity, but remains in the turbulent wake, it may be carried downward and dispersed more rapidly by the turbulence. This can result in either higher or lower concentrations than would occur without the building, depending on whether the reduced height or increased turbulent diffusion has the greater effect.

The height to which the turbulent wake has a significant effect on the plume is generally considered to be about the building height plus 1.5 times the lesser of the building height or width. This results in a height of 2.5 times the building heights for cubic or squat buildings, and less for tall, slender buildings. Since it is considered good engineering practice to build stacks taller than adjacent buildings by this amount, this height came to be called “good engineering practice” (GEP) stack height. Figure 4.4 graphically presents the building downwash concept where the presence of buildings form localized turbulent zones that can readily draw contaminants down to ground level.

Figure 4.4: Building Downwash Effect



4.6.1 Stack Height for Certain New Sources of Contaminants: Good Engineering Practice (GEP) Stack Heights And Structure Influence Zones

Good Engineering Practice (GEP) Stack Heights are the stack heights that the US EPA[(23)] requires to avoid having to consider building downwash effects in dispersion modelling assessments. The definition of GEP is stack heights equal to the building height plus 1.5 times the smaller of the building height or width. If stack heights are less than the height defined by EPA's formula for determining GEP height, then air quality impacts associated with cavity or wake effects due to the nearby building structures must be determined.

Section 15 of the Regulation specifies the stack height to be used in modelling for new stacks as follows:

Stack height for certain new sources of contaminant

"15. (1) This section applies to a source of contaminant if all of the following criteria are met:

1. The source of contaminant discharges contaminants directly into the natural environment.

2. Construction of the source of contaminant began after November 30, 2005.

3. No application was made on or before November 30, 2005 for a certificate of approval in respect of the source of contaminant.

4. The source of contaminant is located in an area around a structure that is bounded by a circle that has a radius of five times the lesser of the following:

i. The height above ground level of the structure.

ii. The greatest width presented to the wind by the structure, measured perpendicularly to the direction of the wind.

(2) If an approved dispersion model other than the ASHRAE method of calculation is used for the purposes of this Part with respect to a source of contaminant to which this section applies, the height at which contaminants are discharged into the air from the source of contaminant that is used with the model must be the lower of the following heights:

1. The actual height above ground level at which contaminants are discharged into the air from the source of contaminant.

2. The higher of the following heights:

i. Sixty-five metres.

ii. The height described in subsection (3).

(3) The height referred to in subparagraph 2 ii of subsection (2) is the height determined by the following formula:

$$A + (1.5 \times B)$$

where,

A = the height above ground level of the structure referred to in

paragraph 4 of subsection (1),

B = the lesser of,

i. the height above ground level of the structure referred to in paragraph 4 of subsection (1), and

ii. the greatest width presented to the wind by the structure referred to in paragraph 4 of subsection (1), measured perpendicularly to the direction of the wind.

(4) If paragraph 4 of subsection (1) applies to a source of contaminant in respect of more than one structure, the references in subsection (3) to the structure referred to in paragraph 4 of subsection (1) shall be deemed to be references to the structure for which the height referred to in subparagraph 2 ii of subsection (2) is the greatest.

(5) This section applies only if the approved dispersion model is used with respect to a person and contaminant to which section 20 applies."

Building downwash for point sources that are within the **Area of Influence** (see Figure 4.5) of a building shall be considered. For US EPA regulatory applications, a building is considered sufficiently close to a stack to cause wake effects when the distance between the stack and the nearest part of the building is less than or equal to five (5) times the lesser of the building height or the projected width of the building.

$$\textbf{Distance}_{\textbf{stack-bldg}} \leq \textbf{5L}$$

For point sources within the **Area of Influence**, building downwash information (direction-specific building heights and widths) shall be included in the modelling project. Using BPIP-PRIME, a proponent can compute the direction-specific building heights and widths.

Structure Influence Zone (SIZ): For downwash analyses with direction-specific building dimensions, wake effects are assumed to occur if the stack is within a rectangle composed of two lines perpendicular to the wind direction, one at **5L** downwind of the building and the other at **2L** upwind of the building, and by two lines parallel to the wind direction, each at **0.5L** away from each side of the building, as shown below. **L** is the lesser of the height or projected width. This rectangular area has been termed a **Structure Influence Zone (SIZ)**. Any stack within the SIZ for any wind direction is potentially affected by GEP wake effects for some wind direction or range of wind directions, and shall be included in the modelling project. Please see Figure 4.5 and Figure 4.6.

Figure 4.5: GEP 5L and Structure Influence Zone (SIZ) Areas of Influence (after U.S. EPA[20]).

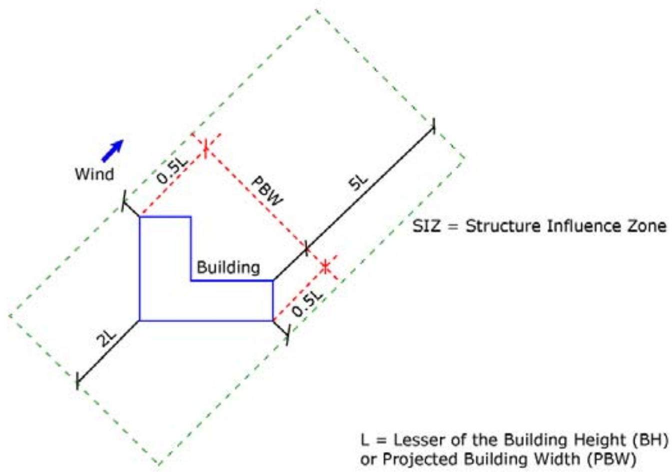
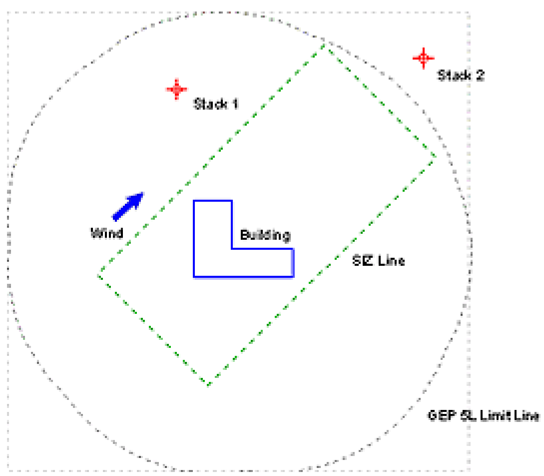


Figure 4.6: GEP 360˚ 5L and Structure Influence Zone (SIZ) Areas of Influence (after U.S. EPA[24]).



4.6.2 Defining Buildings

All of the US EPA approved models allow for the consideration of building downwash. SCREEN3 considers the effects of a single building while AERMOD and ISCPRIME can consider the effects of complicated sites consisting of hundreds of buildings. This results in different approaches to defining buildings which are described below.

SCREEN3 Building Definition

Defining buildings in SCREEN3 is straightforward, as only one building requires definition. The following input data is needed to consider downwash in SCREEN3:

- **Building Height:** The physical height of the building structure in metres.
- **Minimum Horizontal Building Dimension:** The minimum horizontal building dimension in metres.
- **Maximum Horizontal Building Dimension:** The maximum horizontal building dimension in metres.

For **Flare** releases, SCREEN assumes the following:

- an effective stack gas exit velocity (V_s) of 20 m/s,
- an effective stack gas exit temperature (T_s) of 1,273 K, and
- an effective stack diameter based on the heat release rate.

If using **Automated Distances** or **Discrete Distances** option, wake effects are included in any calculations made. Cavity calculations are made for two building orientations, first with the minimum horizontal building dimension along-wind, and second with the maximum horizontal dimension along-wind. The cavity calculations are summarized at the end of the distance-dependent calculations (see SCREEN3 User's Guide(12) Chapter 3.6 for more details).

AERMOD and ISCPRIME Building Definition

The inclusion of the PRIME (Plume Rise Model Enhancements) algorithm(21) to compute building downwash has produced more accurate results in air dispersion models. Unlike the earlier algorithms used in ISCST3, the PRIME algorithm:

1. accounts for the location of the stack relative to the building;
2. accounts for the deflection of streamlines up over the building and down the other side;
3. accounts for the effects of the wind profile at the plume location for calculating plume rise;
4. accounts for contaminants captured in the recirculation cavity to be transported to the far wake downwind (this was ignored in the earlier algorithms); and

5. avoids discontinuities in the treatment of different stack heights, which were a problem in the earlier algorithms.

Models such as AERMOD and ISCPRIME allow for the capability to consider downwash effects from multiple buildings. AERMOD and ISCPRIME require building downwash analysis to first be performed using BPIP-PRIME(21). The results from BPIP-PRIME can then be incorporated into the modelling studies for consideration of downwash effects.

The US EPA Building Profile Input Program – Plume Rise Model Enhancements (BPIP-PRIME) was designed to incorporate enhanced downwash analysis data for use with the US EPA ISCPRIME and current AERMOD models. Similar in operation to the US EPA BPIP model, which is used with ISCST3, BPIP-PRIME uses the same input data requiring no modifications of existing BPIP projects. The following information is required to perform building downwash analysis within BPIP/BPIP-PRIME:

- X and Y location for all stacks and building corners.
- Height for all stacks and buildings (metres). For building with more than one height or roofline, identify each height (tier).
- Base elevations for all stacks and buildings.

The BPIP User's Guide(22) provides details on how to input building and stack data to the program.

BPIP-PRIME is divided into two parts.

- **Part One:** Based on the GEP technical support document,(23) this part is designed to determine whether or not a stack is subject to wake effects from a structure or structures. Values are calculated for GEP stack height and GEP related building heights (BH) and projected building widths (PBW). Indication is given to which stacks are being affected by which structure wake effects.
- **Part Two:** This part calculates building downwash BH and PBW values based on references by Tikvart(24,25) and Lee.(26) These can be different from those calculated in Part One. The calculations are performed only if a stack is being influenced by structure wake effects.

In addition to the standard variables reported in the output of BPIP, BPIP-PRIME adds the following:

- **BUILDLEN:** Projected length of the building along the flow.

- **XBADJ:** Along-flow distance from the stack to the centre of the upwind face of the projected building.

- **YBADJ:** Across-flow distance from the stack to the centre of the upwind face of the projected building.

For a more detailed technical description of the EPA BPIP-PRIME model and how it relates to the US EPA ISCPRIME model see the *Addendum to ISC3 User's Guide.*[27]

5.0 GEOGRAPHICAL INFORMATION INPUTS

5.1 Comparison of SCREEN3 with AERMOD and ISCPRIME Model Requirements

Geographical information requirements range from basic (for screening analyses) to advanced (for more sophisticated modelling). SCREEN3 makes use of geographical information only for complex or elevated terrain; it requires simply the distance from the source and the height in a straight-line. The AERMOD and ISCPRIME models make use of complete three-dimensional geographic data with support for digital elevation model files and real-world spatial characterization of all model objects. As explained below, sections 16 and 26 of the Regulation require geographical information to be considered.

5.2 Coordinate System

5.2.1 Local

Local coordinates encompass coordinate systems that are not based on a geographic standard. For example, a facility may reference its coordinate system based on a local set datum, such as a predefined benchmark. All site measurements can relate to this benchmark which can be defined as the origin of the local coordinate system with coordinates of 0,0 m. All facility buildings and sources could then be related spatially to this origin. However, local coordinates do not indicate where in the actual world the site is located. For this reason, it is advantageous to consider a geographic coordinate system that can specify the location of any object anywhere in the world with precision.

5.2.2 UTM

The coordinate system most commonly used for air dispersion modelling is the Universal Transverse Mercator (UTM) system which uses metres as its basic unit of measurement and allows for more precise definition of specific locations than latitude/longitude.

It is important to ensure that all model objects (sources, buildings, receptors) are defined in the same horizontal datum, NAD83 (North American datum of 1983) or NAD27 (North American datum of 1927). Defining some objects based on a NAD27 while defining others within a NAD83 can lead to significant errors in relative locations.

5.3 Terrain

5.3.1 Terrain Concerns in Short-Range Modelling

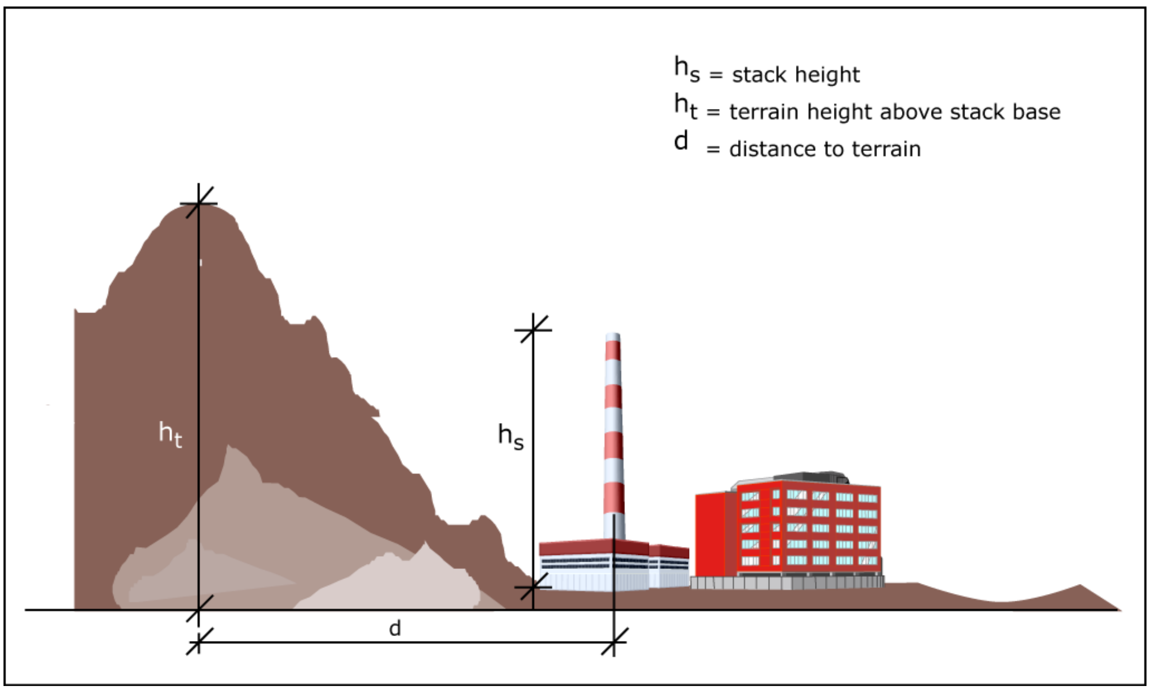
Terrain elevations can have a large impact on the air dispersion and deposition modelling results and therefore on the estimates of potential risk to human health and the environment. Terrain elevation is the elevation relative to the facility base elevation. Chapter 5.3.2 describes the primary types of terrain. Although the consideration of a terrain type is dependent on the study area, the definitions below must be considered when determining the characteristics of the terrain for the modelling analysis.

5.3.2 Flat and Complex Terrain

The models consider three different categories of terrain as follows:

- **Complex Terrain:** as illustrated in Figure 5.1, where terrain elevations for the surrounding area, are above the top of the stack being evaluated in the air modelling analysis.

Figure 5.1 : Sample Complex Terrain Conditions

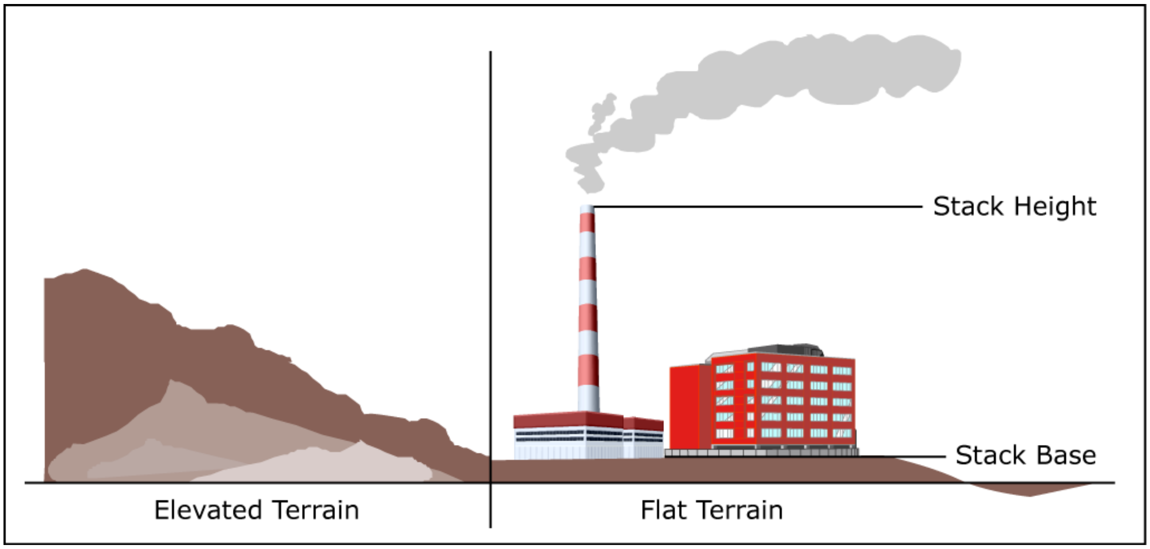


- **Simple Terrain:** where terrain elevations for the surrounding area are not above the top of the stack being evaluated in the air modelling analysis. The "Simple" terrain can be divided into two categories:

- **Simple Flat Terrain** is used where terrain elevations are assumed not to exceed stack base elevation. If this option is used, then terrain height is considered to be 0.0 m.

- **Simple Elevated Terrain**, as illustrated in Figure 5.2 is used where terrain elevations exceed stack base but are below stack height.

Figure 5.2: Sample Elevated and Flat Terrain Conditions



5.3.3 Criteria for Use of Terrain Data

Section 16 of the Regulation sets out when terrain must be considered. Section 16 of the Regulation states:

Terrain data

"16. (1) If an approved dispersion model is used for the purposes of this Part with respect to any point of impingement that has an elevation higher than the lowest point from which the relevant contaminant is discharged from a source of contaminant, the model shall be used in a manner that employs terrain data.

(2) This section does not apply if the approved dispersion model that is used is,

(a) the ASHRAE method of calculation;

(b) the method of calculation required by the Appendix to Regulation 346; or

(c) a dispersion model or combination of dispersion models that, pursuant to subsection 7 (3), is deemed to be included in references in this Part to approved dispersion models, if the dispersion model or combination of dispersion models is not capable of using terrain data."

Evaluation of terrain within a study area is the responsibility of the proponent. At first glance it might be inferred that much of Ontario is flat, but it should be kept in mind that both the terrain elevation relative to the source release heights and the proximity of the terrain features to the facility affect their impact. Screening model runs (i.e., SCREEN3) could be used to determine if terrain features could result in higher concentrations.

The appropriate terrain environment can be determined through the use of digital elevation data or other geographic data sources. It should be noted that the models such as, ISCPRIME and AERMOD, have similar run times regardless of whether or not terrain data is used. However AERMAP, the terrain pre-processor for AERMOD, does require additional time. If analysis of the terrain environment is performed using digital terrain data, minimal resources are required to execute a model run using that digital terrain data set.

5.3.4 Obtaining Terrain Data

Digital elevation model (DEM) data covering Ontario suitable for use with AERMOD and ISCPRIME is available through the Ministry of the Environment's Public Information Centre: 135 St. Clair Avenue West, 1st floor, Toronto, ON M4V 1P5, 416-325-4000, 1-800-565-4923 [Ontario Digital Elevation Model Data (PIBs # 5106e)] or the MOE web-site at

www.ene.gov.on.ca/envision/air/regulations/demdata/dem.html . The DEM data is in 7.5 minute format data (resolution 1:25,000) which can be used directly with the AERMOD terrain pre-processor AERMAP.

Terrain data is also available from Natural Resources Canada. It is in a format called CDED (Canadian Digital Elevation Data), and can be obtained at 1-degree or 15-minute spatial resolutions.

5.3.5 Preparing Terrain Data for Model Use

AERMAP is the digital terrain pre-processor for the AERMOD model. It analyzes and prepares digital terrain data for use within an air dispersion modelling project. AERMAP requires that the digital terrain data files be in native United States Geological Survey (USGS) 1-degree or 7.5-minute DEM format.

The CDED format is very similar to the USGS DEM format. The CDED 1-degree data type can be used directly with AERMAP without the need for any conversions. However, 1-degree data does not contain optimal resolution for most air dispersion modelling analyses. The CDED 15-minute data type requires conversion to an AERMAP compatible format.

A digital terrain converter is commercially available to specifically address the need for higher-resolution Canadian terrain data in a format compatible with the AERMAP terrain pre-processor. Refer to Chapter 5.2.2 on the UTM coordinate system.

5.4 Land Use Characterization

Land use plays an important role in air dispersion modelling from meteorological data processing to defining modelling characteristics such as urban or rural conditions. Land use information is required by subsection 26(1)10 of the Regulation.

Contents of ESDM report (Section 26 of the Regulation)

"…. 10. A description of the local land use conditions, if meteorological data described in paragraph 2 of subsection 13 (1) was used when using an approved dispersion model for the purpose of this section. …."

Land use data can be obtained from digital and paper land-use maps. These maps will provide an indication into the dominant land use types within an area of study, such as industrial, agricultural, forested and others. This information can then be used to determine dominant dispersion conditions and estimate values for the critical surface characteristics which are surface roughness length, albedo, and the Bowen ratio.

In 2008 the US EPA released the AERSURFACE tool, part of the AERMOD modelling system, to assist users in the appropriate selection of surface characteristics for different land use categories in the vicinity of a facility or site. These characteristics are then input into AERMET which determines the appropriate dispersion parameters for each area/sector surrounding the site. Consult the AERSURFACE User's Guide[28] for specific guidance on using AERSURFACE.

The AERSURFACE tool was designed to use US Geological Survey (USGS) National Land Cover Data 1992 (NLCD92), which includes 21 separate land cover categories. Similar data is generally available from the MNR for most rural areas in the province. Data for some urban areas is also available from other sources. Proponents should contact EMRB to determine whether the MOE has AERSURFACE-ready files for the specific area to be modelled. In cases where the necessary data is not available electronically, users should obtain land use data from appropriate municipal land use maps or from site-specific/area observations, and determine the surface characteristics manually, as described below in sections 5.4.1 – 5.4.3. Note that the use of site-specific observations is always preferable to other data sources. The source data (maps) and resulting files should be submitted to EMRB for review and approval.

Note that the use of AERSURFACE is not required; users may specify the land use characteristics manually, if preferred. Users should follow the recommendations for determining surface characteristics as presented in Section 3.1 of the AERMOD Implementation guide, 2008[29] or Section 2.3 of the AERSURFACE User's guide.

It should also be noted that the seasonal characteristics in the US EPA User's Guides[28,29] are based on 5 categories rather than the traditional 4 seasons. However, this approach is more subjective, as it requires user decisions on the land use conditions during specific periods. As a result, the MOE has maintained use of the 4 traditional seasons, in a manner consistent with the seasonal definitions in both AERMOD and ISCPRIME. These are as follows:

- winter (December – February)
- spring (March – May)
- summer (June – August)
- autumn (September – November)

These periods should be used to apply any seasonal variations in surface characteristics.

5.4.1 Surface Roughness Length [m]

The surface roughness length, also referred to as surface roughness height, is a measure of the height of obstacles to the wind flow. Surface roughness affects the

height above local ground level that a particle moves from the ambient air flow above the ground into a “captured” deposition region near the ground. This height is not equal to the physical dimensions of the obstacles, but is generally proportional to them. For many modelling applications, the surface roughness length can be considered to be on the order of one tenth of the height of the roughness elements.

Figure 5.3: Effect of Surface Roughness

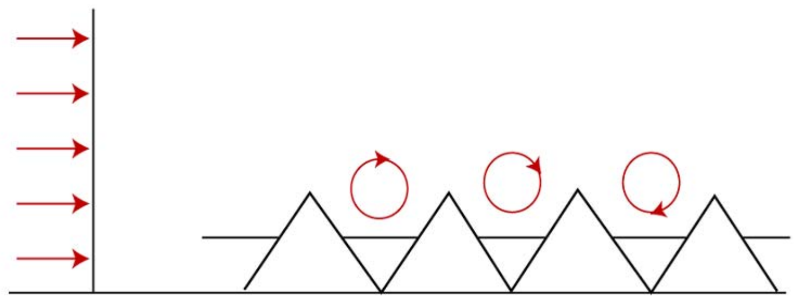


Table 5. lists typical surface roughness lengths for a range of land-use types as a function of season.

Table 5.1: Surface Roughness Lengths for Land Use Types and Seasons (metres)[28]

Class Number	Land Use Class Name	Spring	Summer	Autumn	Winter
11	Open Water	0.001	0.001	0.001	0.001
12	Perennial Ice/Snow	0.002	0.002	0.002	0.002
21	Low Intensity Residential	0.52	0.54	0.54	0.5
22	High Intensity Residential	1	1	1	1
23	Commercial/Industrial/Transportation (at Airport)	0.1	0.1	0.1	0.1
	Commercial/Industrial/Transportation (Not at Airport)	0.8	0.8	0.8	0.8
31	Bare Rock/Sand/Clay (Arid Region)	0.05	0.05	0.05	
	Bare Rock/Sand/Clay (Non-arid Region)	0.05	0.05	0.05	0.05
32	Quarries/Strip Mines/Gravel	0.3	0.3	0.3	0.3
33	Transitional	0.2	0.2	0.2	0.2
41	Deciduous forest	1	1.3	1.3	0.5
42	Coniferous forest	1.3	1.3	1.3	1.3
43	Mixed Forest	1.15	1.3	1.3	0.9
51	Shrubland (Arid Region)	0.15	0.15	0.15	
	Shrubland (Non-arid Region)	0.3	0.3	0.3	0.15
61	Orchards/Vineyards/Other	0.2	0.3	0.3	0.05
71	Grasslands/Herbaceous	0.05	0.1	0.1	0.005
81	Pasture/Hay	0.03	0.15	0.15	0.01
82	Row Crops	0.03	0.2	0.2	0.01
83	Small Grains	0.03	0.15	0.15	0.01
84	Fallow	0.02	0.05	0.05	0.01
85	Urban/Recreational Grasses	0.015	0.02	0.015	0.005

Class Number	Land Use Class Name	Spring	Summer	Autumn	Winter
91	Woody Wetlands	0.7	0.7	0.7	0.5
92	Emergent Herbaceous Wetlands	0.2	02	0.2	0.1

This Table contains 6 columns and one header row. The first column lists the Land Use Class Number, the second column lists the Land Use Class Name and the remaining four columns list the corresponding Spring, Summer, Autumn, and Winter values respectively.

AERMOD allows wind direction dependent surface characteristics to be used in the processing of the meteorological data. AERMET uses the area-weighted average of the land use within a specified distance of the site. The U.S. EPA AERSURFACE User's Guide allows a radius of influence of 0.1 to 5 km to be used for surface roughness calculations, with a recommended distance of 1 km. A radius of influence longer than 1 km would be a reasonable choice for lower roughness lengths. The U.S. EPA 2009 AERMOD Implementation Guide(29) recommends that the assessment be performed at the meteorological tower site. It should be noted that when incorporating local land use conditions into dispersion modelling assessments for the MOE, the conditions surrounding the facility should be specified, rather than the meteorological tower. Also, given the relatively large size of many facilities and the building heights at these locations the Ministry will continue to recommend that a 3 km distance from the facility be used when specifying local land use conditions unless the facility is located in an urban environment.

The selection of wind direction and seasonally dependent land use is described in Chapter 5.4.4. Alternative methods of determining surface roughness lengths may be used, but pre-approval must be obtained from the MOE (Tier 3 Modelling).

5.4.2 Noon-Time Albedo

Noon-time albedo is the fraction of the incoming solar radiation that is reflected from the ground when the sun is directly overhead (see Figure 5.4). Table 5. lists typical albedo values as a function of several land use types and season.

Figure 5.4: Variations in Albedo Ratios Depending on Ground Cover

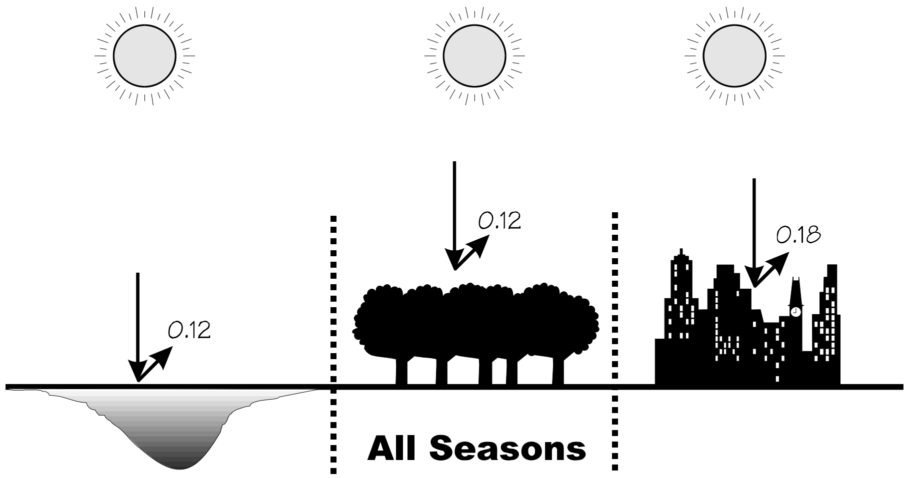


Table 5.2: Albedo of Natural Ground Covers for Land Use Types and Seasons[31]

Class Number	Land use Type	Spring	Summer	Autumn	Winter
11	Open Water	0.1	0.1	0.1	0.1
12	Perennial Ice/Snow	0.6	0.6	0.6	0.7
21	Low Intensity Residential	0.16	0.16	0.16	0.45
22	High Intensity Residential	0.18	0.18	0.18	0.35
23	Commercial/Industrial/Transportation (at Airport)	0.18	0.18	0.18	0.35
	Commercial/Industrial/Transportation (Not at Airport)	0.18	0.18	0.18	0.35
31	Bare Rock/Sand/Clay (Arid Region)	0.2	0.2	0.2	
	Bare Rock/Sand/Clay (Non-arid Region)	0.2	0.2	0.2	0.6
32	Quarries/Strip Mines/Gravel	0.2	0.2	0.2	0.6
33	Transitional	0.18	0.18	0.18	0.45
41	Deciduous forest	0.16	0.16	0.16	0.5
42	Coniferous forest	0.12	0.12	0.12	0.35
43	Mixed Forest	0.14	0.14	0.14	0.42
51	Shrubland (Arid Region)	0.25	0.25	0.25	
	Shrubland (Non-arid Region)	0.18	0.18	0.18	0.5
61	Orchards/Vineyards/Other	0.14	0.18	0.18	0.5
71	Grasslands/Herbaceous	0.18	0.18	0.18	0.6
81	Pasture/Hay	0.14	0.2	0.2	0.6
82	Row Crops	0.14	0.2	0.2	0.6
83	Small Grains	0.14	0.2	0.2	0.6
84	Fallow	0.18	0.18	0.18	0.6
85	Urban/Recreational Grasses	0.15	0.15	0.15	0.6
91	Woody Wetlands	0.14	0.14	0.14	0.3

Class Number	Land use Type	Spring	Summer	Autumn	Winter
92	Emergent Herbaceous Wetlands	0.14	0.14	0.14	0.3

This Table contains 6 columns and one header row. The first column lists the Land Use Class Number, the second column lists the Land Use Class Name and the remaining four columns list the corresponding Spring, Summer, Autumn, and Winter values respectively.

5.4.3 Bowen Ratio

The Bowen ratio is a measure of the amount of moisture at the surface. The presence of moisture at the earth's surface alters the energy balance, which in turn alters the sensible heat flux and Monin-Obukhov length. Table 5. lists Bowen ratio values as a function of land-use types, seasons and moisture conditions. Bowen ratio values vary depending on the surface wetness. **Proponents shall use the average precipitation (moisture) conditions for selecting the Bowen ratio to pre-process meteorological data.** If a proponent wishes to use other conditions, pre-approval must be obtained from the MOE (Tier 3).

Table 5.3: Daytime Bowen Ratios by Land Use and Season for Dry Precipitation Conditions[28]

Class Number	Land Use Class Name	Seasonal Bowen Ratio - Average				Seasonal Bowen Ratio - Wet				Seasonal Bowen Ratio - Dry			
		Spring	Summer	Autumn	Winter	Spring	Summer	Autumn	Winter	Spring	Summer	Autumn	Winter
11	Open Water	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
12	Perennial Ice/Snow	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
21	Low Intensity Residential	0.8	0.8	1	0.5	0.6	0.6	0.6	0.5	2	2	2.5	0.5
22	High Intensity Residential	1.5	1.5	1.5	0.5	1	1	1	0.5	3	3	3	0.5
23	Commercial/Industrial/Transportati	1.5	1.5	1.5	0.5	1	1	1	0.5	3	3	3	0.5
	Commercial/Industrial/Transportati	1.5	1.5	1.5	0.5	1	1	1	0.5	3	3	3	0.5
31	Bare Rock/Sand/Clay (Arid	3	4	6		1	1.5	2		5	6	10	
	Bare Rock/Sand/Clay (Non-arid	1.5	1.5	1.5	0.5	1	1	1	0.5	3	3	3	0.5
32	Quarries/Strip Mines/Gravel	1.5	1.5	1.5	0.5	1	1	1	0.5	3	3	3	0.5
33	Transitional	1	1	1	0.5	0.7	0.7	0.7	0.5	2	2	2	0.5
41	Deciduous forest	0.7	0.3	1	0.5	0.3	0.2	0.4	0.5	1.5	0.6	2	0.5
42	Coniferous forest	0.7	0.3	0.8	0.5	0.3	0.2	0.3	0.5	1.5	0.6	1.5	0.5
43	Mixed Forest	0.7	0.3	0.9	0.5	0.3	0.2	0.35	0.5	1.5	0.6	1.75	0.5
51	Shrubland (Arid Region)	3	4	6		1	1.5	2		5	6	10	
	Shrubland (Non-arid Region)	1	1	1.5	0.5	0.8	0.8	1	0.5	2.5	2.5	3	0.5
61	Orchards/Vineyards/Other	0.3	0.5	0.7	0.5	0.2	0.3	0.4	0.5	1	1.5	2	0.5
71	Grasslands/Herbaceous	0.4	0.8	1	0.5	0.3	0.4	0.5	0.5	1	2	2	0.5
81	Pasture/Hay	0.3	0.5	0.7	0.5	0.2	0.3	0.4	0.5	1	1.5	2	0.5
82	Row Crops	0.3	0.5	0.7	0.5	0.2	0.3	0.4	0.5	1	1.5	2	0.5
83	Small Grains	0.3	0.5	0.7	0.5	0.2	0.3	0.4	0.5	1	1.5	2	0.5
84	Fallow	0.3	0.5	0.7	0.5	0.2	0.3	0.4	0.5	1	1.5	2	0.5
85	Urban/Recreational Grasses	0.3	0.5	0.7	0.5	0.2	0.3	0.4	0.5	1	1.5	2	0.5
91	Woody Wetlands	0.2	0.2	0.3	0.5	0.1	0.1	0.1	0.5	0.2	0.2	0.2	0.5
92	Emergent Herbaceous Wetlands	0.1	0.1	0.1	0.5	0.1	0.1	0.1	0.5	0.2	0.2	0.2	0.5

This Table contains 14 columns and one header row. The first column lists the Land Use Class Number, the second column lists the Land Use Class Name and the remaining three groups of four columns list the corresponding Spring, Summer, Autumn, and Winter values for Average, Wet and Dry conditions, respectively.

5.4.4 Wind Direction and Seasonally Dependent Land Use

AERMET provides the ability to specify land characteristics for up to 12 different contiguous, non-overlapping wind direction sectors that define unique upwind surface characteristics. The following properties of wind sectors must be true:

- The sectors must be defined clockwise as the direction *from which the wind is blowing*, with north at 0°.
- The sectors must cover the full circle so that the end value of one sector matches the beginning of the next sector.
- The beginning direction is considered part of the sector, while the ending direction is not.

Each wind sector can have a unique surface roughness length based on the weighted average of the land use categories within 3 km of the site for that sector. AERMET allows these surface characteristics to be specified annually, seasonally, or monthly to better reflect site conditions. For example, winter conditions can bring increased albedo values due to snow accumulation. Proponents should consult the AERSURFACE User's Guide or contact EMRB for detailed guidance.

When modelling with ISCPRIME, there are no applicable modifications to the meteorological file to consider site specific land use characteristics when the model regulatory defaults are used. However, for Tier 3 assessments that may consider non-regulatory defaults (subject to MOE approval) such as plume depletion and dry deposition, modifications can be made to consider these characteristics. This would affect only the surface roughness length, friction velocity and Monin-Obukhov Length, which are additional parameters that are required to compute deposition and depletion. The ISCPRIME-ready meteorological data available from the MOE web site (Section 6.3) does not contain the data for wet or dry deposition. As indicated previously, use of deposition and depletion requires prior approval from MOE. Proponents wishing to use these should contact the MOE for approval and further guidance related to the incorporation of site specific land use characteristics.

5.4.5 Defining Urban and Rural Conditions

ISCPRIME requires a designation of the site as being in a predominantly urban or rural setting. The US EPA document *Guideline on Air Quality Models (40 CFR Part 51, Appendix W*[(8)] describes procedures for classifying sites as urban or rural, and requires that either a land use classification procedure or a population based procedure be used in this determination. The land use procedure is considered a more definitive criterion, and shall be used by proponents for the purposes of the Regulation. If a proponent wishes to use the population density procedure, pre-approval from the MOE must be obtained (Tier 3 Modelling).

Land Use Procedure: The land use within a 3 km radius around the facility sources is examined. If more than 50% of the area is accounted for by land use categories ranging from multi-family dwelling to commercial and industrial use it is classified as urban. Otherwise the site is classified as rural.

Population Density Procedure: Compute the average population density within a 3 km radius around the facility sources. The designation of urban or rural is the given by:

(a) If $\boldsymbol{p}$ > 750 people/km^2, select the **Urban** option,

If $\boldsymbol{p}$ <= 750 people/km^2, select the **Rural** option.

The population density procedure should be used with caution and must not be applied to highly industrialized areas where the population density may be low and thus a rural classification would be indicated, but the area is sufficiently built-up so that the urban land use criteria would be satisfied.

6.0 METEOROLOGICAL DATA

Section 13 of the Regulation specifies the types of meteorological information that can be used with an approved dispersion model as follows:

Meteorological data

"13. (1) An approved dispersion model that is used for the purposes of this Part shall be used with one of the following types of meteorological information:

1. Regional surface and upper air meteorological data for the part of Ontario in which the source of contaminant is located that was available on May 14, 2007, and continues to be available, through a website maintained by the Ministry on the internet or through the Ministry's Public Information Centre.

1.1 Data described in paragraph 1 that has been processed by the AERMET computer program, as that program is amended from time to time, and that is available through a website maintained by the Ministry on the Internet or through the Ministry's Public Information Centre, if the approved dispersion model that is used is the AERMOD dispersion model described in paragraph 1 of subsection 6 (1).

2. Data described in paragraph 1.1 that has been refined to reflect local land use conditions, if the approved dispersion model that is used is the AERMOD dispersion model described in paragraph 1 of subsection 6 (1).

2.1 Data described in paragraph 1 that has been processed by the PCRAMMET computer program, as that program is amended from time to time, and that is available through a website maintained by the Ministry on the Internet or through the Ministry's Public Information Centre, if the approved dispersion model that is used is the ISCPRIME dispersion model described in paragraph 3 of subsection 6 (1).

3. Local or site-specific meteorological data approved by the Director as an accurate reflection of meteorological conditions.

4. Data obtained from a computational method, if the Director is of the opinion that the data is at least as accurate as data that would be obtained by local or site-specific meteorological monitoring.

(2) Despite subsection (1), the Director may give written notice to a person who discharges or causes or permits the discharge of a contaminant requiring that an approved dispersion model that is used for the purposes of this Part be used with a type of meteorological information specified in the notice that, in the opinion of the Director, accurately reflects meteorological conditions.

(3) Before the Director gives a person a notice under subsection (2), the Director shall give the person a draft of the notice and an opportunity to make written submissions to the Director during the period that ends 30 days after the draft is given.

(4) This section does not apply if the approved dispersion model that is used is,

(a) the ASHRAE method of calculation;

(b) the SCREEN3 dispersion model described in paragraph 4 of subsection 6 (1);

(c) the method of calculation required by the Appendix to Regulation 346; or

(d) a dispersion model or combination of dispersion models that, pursuant to subsection 7 (3), is deemed to be included in references in this Part to approved dispersion models, if the dispersion model or combination of dispersion models is not capable of using meteorological data.

6.1 Comparison of SCREEN3 with AERMOD and ISCPRIME Model Requirements

Meteorological data is essential for air dispersion modelling as it describes the primary environment through which the contaminants being studied migrate. Similar to other data requirements, screening model requirements are less demanding than the more advanced models.

SCREEN3 provides three methods of defining meteorological conditions without using actual meteorological data or measurements. These are as follows:

1. **Full Meteorology:** SCREEN3 will examine all six stability classes (five for urban sources) and their associated wind speeds. SCREEN3 examines a range of stability classes and wind speeds to identify the "worst case"

meteorological conditions, i.e., the combination of wind speed and stability that results in the maximum concentrations.

2. **Single Stability Class:** The modeller can select the stability class to be used (A through F). SCREEN3 will then examine a range of wind speeds for that stability class only.

3. **Single Stability Class and Wind Speed:** The modeller can select the stability class and input the 10-metre wind speed to be used. SCREEN3 will examine only that particular stability class and wind speed.

Screening-level meteorological data may also be used with the more advanced models in a Tier 1 assessment, specifically in cases where there are multiple sources at a facility. Use of the MOE approach with SCREEN3 (where the results from each individual source are added together) may be too conservative. As a result, the MOE has prepared a screening-level meteorological data set for use with ISCPRIME. This data set can be obtained from the MOE for use in Tier 1 assessments, and represents an artificial meteorological data set that incorporates the full range of possible wind directions and meteorological conditions.

In order to minimize model run times the wind directions in this data set are varied in increments of 10° which results in fewer data points in comparison to the regional meteorological data sets. However, model runs completed using this dataset must use both Cartesian and Polar receptor grids, and the Polar grid must match the wind directions in the data set. Also, the model may be used only to generate maximum predicted hourly concentrations. Maximum concentrations for other averaging time periods can be estimated using the power law equation specified in s.17 of the Regulation and described in Chapter 4.4.

6.2 Preparing Meteorological Data for use with AERMOD and ISCPRIME Dispersion Modelling

AERMOD and ISCPRIME require actual hourly meteorological conditions as inputs. These models require pre-processed meteorological data that contains information on surface characteristics and upper air definition. This data is typically provided in a raw or partially processed format that requires processing through a meteorological pre-processor. ISCPRIME makes use of a pre-processor called PCRAMMET, while AERMOD uses a pre-processor known as AERMET. These pre-processors are described further below.

6.2.1 Hourly Surface Data

Hourly surface data is supported in several formats including CD-144 file format, SCRAM surface data file format and SAMSON surface data as shown below.

(a) **<u>CD-144 – NCDC Surface Data</u>:** This file is composed of one record per hour, with all weather elements reported in an 80-column card image. Table 6-1 lists the data contained in the CD-144 file format that is needed to pre-process your meteorological data.

Table 6-1: CD-144 Surface Data Record (80 Byte Record)

Element	Columns
Surface Station Number	1-5
Year	6-7
Month	8-9
Day	10-11
Hour	12-13
Ceiling Height (Hundreds of Feet)	14-16
Wind Direction (Tens of Degrees)	39-40
Wind Speed (Knots)	41-42
Dry Bulb Temperature (°Fahrenheit)	47-49
Opaque Cloud Cover	79

This Table contains two columns and one header row. The first lists the individual elements, and the second the corresponding column numbers (or ranges of numbers).

(b) MET-144 – SCRAM Surface Data: The SCRAM surface data format is a reduced version of the CD-144 data with fewer weather variables (28-character record). Table 6-2 lists the data contained in the SCRAM file format.

Table 6-2: SCRAM Surface Data Record (28 Byte Record)

Element	Columns
Surface Station Number	1-5
Year	6-7
Month	8-9
Day	10-11
Hour	12-13
Ceiling Height (Hundreds of Feet)	14-16
Wind Direction (Tens of Degrees)	17-18
Wind Speed (Knots)	19-21
Dry Bulb Temperature (° Fahrenheit)	22-24
Total Cloud Cover (Tens of Percent)	25-26
Opaque Cloud Cover (Tens of Percent)	27-28

This Table contains two columns and one header row. The first lists the individual elements and the second the corresponding column numbers (or ranges of numbers).

The SCRAM data do not contain the following weather variables, which are necessary for dry and wet particle deposition analysis:

i. **Surface pressure:** for dry and wet particle deposition;

ii. **Precipitation type:** for wet particle deposition only; or

iii. **Precipitation amount:** for wet particle deposition only.

(c) SAMSON Surface Data: The SAMSON data contains all of the required meteorological variables for concentration, dry and wet particle deposition, and wet vapour deposition.

If the processing of raw data is necessary, the surface data must be in one of the above formats in order to successfully pre-process the data using PCRAMMET or AERMET. Canadian hourly surface data can be obtained from Environment Canada. Regional pre-processed meteorological data sets can be obtained from the Public Information Centre [Ontario Regional Meteorological Data (PIBs # 5081e01)] or the MOE web-site at www.ene.gov.on.ca.

6.2.2 Mixing Height and Upper Air Data

Upper air data, also known as mixing height data, are required for pre-processing the meteorological data that is needed to run AERMOD and ISCPRIME. It is recommended that only years with complete mixing height data be used. In some instances, mixing height data may need to be obtained from more than one station to complete multiple years of data. Mixing height data are available from:

1. **SCRAM BBS –**download free of charge, mixing height data for the US for years 1984 through 1991.
2. **Environment Canada –**purchase mixing height data for appropriate regions.
3. **U.S. National Climatic Data Center** –purchase data for appropriate regions.
4. **WebMET.com –**download free of charge, mixing height and upper air data from across North America, including Ontario.

Table 6-3 lists the format of the mixing height data file used by PCRAMMET.

Table 6-3: Upper Air Data File (SCRAM / NCDC TD-9689 Format)

Element	Columns
Upper Air Station Number (WBAN)	1-5
Year	6-7
Month	8-9
Day	10-11
AM Mixing Value	14-17
PM Mixing Value (NCDC) PM Mixing Value (SCRAM)	25-28 32-35

This Table contains two columns and one header row. The first lists the individual elements, and the second the corresponding column numbers (or ranges of numbers).

AERMOD requires the full upper air sounding, unlike ISCPRIME, which only require the mixing heights. The upper air soundings must be in the NCDC TD-6201 file format or one of the FSL formats. This is available from the Public Information Centre [Ontario Regional Meteorological Data (PIBs # 5081e01)] or the MOE web-site at www.ene.gov.on.ca/envision/air/regulations/metdata/met.htm.

6.2.3 AERMET and the AERMOD Model

The AERMET program is a meteorological pre-processor which prepares hourly surface data and upper air data for use in the US EPA air quality dispersion model AERMOD. AERMET was designed to allow for future enhancements to process other types of data and to compute boundary layer parameters with different algorithms.

AERMET processes meteorological data in three stages:

1. The first stage (Stage1) extracts meteorological data from archive data files and processes the data through various quality assessment checks.

2. The second stage (Stage2) merges all data available for 24-hour periods (surface data, upper air data, and on-site data) and stores these data together in a single file.

3. The third stage (Stage3) reads the merged meteorological data along with land use data (Chapter 5.4) to estimate the necessary boundary layer parameters for use by AERMOD.

Out of this process two files are written for AERMOD:

1. A Surface File of hourly boundary layer parameters estimates; and

2. A Profile File of multiple-level observations of wind speed, wind direction, temperature, and standard deviation of the fluctuating wind components.

6.2.4 PCRAMMET and the ISCPRIME Model

The PCRAMMET program is a meteorological pre-processor which prepares National Weather Service (NWS) data for use in the various US EPA air quality dispersion models such as ISCPRIME.

PCRAMMET is also used to prepare meteorological data for use by the CAL3QHCR model, and for use by the CALPUFF puff dispersion model when used in screening mode.

The operations performed by PCRAMMET include:

- calculating hourly values for atmospheric stability from meteorological surface observations;

- interpolating the twice daily mixing heights to hourly values;

- optionally, calculating the parameters for dry and wet deposition processes;

- outputting data in the standard (PCRAMMET unformatted) or ASCII format required by air quality dispersion models.

The input data requirements for PCRAMMET depend on the dispersion model and the model options for which the data is being prepared. The minimum input data requirements for PCRAMMET are:

- the twice-daily mixing heights, and
- the hourly surface observations of: wind speed, wind direction, dry bulb temperature, opaque cloud cover, and ceiling height.

For dry deposition estimates, station pressure measurements, surface roughness length, friction velocity and Monin-Obukhov Length are required. For wet deposition estimates, precipitation type and hourly precipitation amount measurements for those periods where precipitation was observed are required. The US EPA “Regulatory default” option of the model does not consider deposition.

The surface and upper air stations shall be selected to ensure they are meteorologically representative of the general area being modelled.

6.3 MOE Regional Meteorological Data

The MOE has prepared regional meteorological data sets for use in Tier 2 modelling using AERMOD or ISCPRIME. These are standard data sets that can be used for air quality studies using AERMOD or ISCPRIME.

For ISCPRIME there are regional meteorological data sets pre-processed with PCRAMMET ready for use with the model. For AERMOD, the meteorological data sets are available in two formats, as described below:

- Regional pre-processed model ready data for AERMOD, with land characteristics for CROP, RURAL and URBAN conditions.
- Pre-processed hourly surface data and upper air data files allowing for complete processing through AERMET stages 1, 2 and 3, which allows consideration of site specific local land use conditions.

The above data sets are available from the MOE [Ontario Regional Meteorological Data (PIBs # 5081e01)] or the MOE web-site, www.ene.gov.on.ca/envision/air/regulations/metdata/met.htm and provide a unique, easily accessible resource for air dispersion modellers in the province of Ontario (see Section 13 of the Regulation). The availability of standard meteorological data will reduce inconsistencies in data quality and requests to the MOE for meteorological data sets. The regional data sets shall not be modified. If the pre-processed data sets are used with site specific land use conditions, this must be documented in the submission as per Section 26(1) paragraph 10 of the Regulation.

Each regional data set was developed using surface and upper air data from the nearest representative meteorological station. The surface meteorological sites used were Toronto (Pearson Airport), London, Sudbury and Ottawa along with International Falls, MN and Massena, NY. The following meteorological elements were used in AERMET processing for the 5 year period from 1996 to 2000:

- ceiling height;
- wind speed;
- wind direction;
- air temperature;
- total cloud opacity; and
- total cloud amount.

The upper air stations used were Maniwaki, QC, White Lake, MI, Buffalo, NY, Albany, NY and International Falls, MN. Table 6-4 gives the locations of the surface meteorological sites and lists the upper air station to be used for each site. The locations of the upper air sites are given in Table 6-5.

Table 6-4: Location of Surface Meteorological Sites

Surface station	ID	Latitude	Longitude	Height above sea level, m	Province/ State	UA to use
Sudbury	6068150	46.62	-80.8	348	ON	White Lake
Ottawa	6106000	45.32	-75.67	114	ON	Maniwaki
London	6144475	43.03	-81.15	278	ON	White Lake
Toronto	6158733	43.67	-79.6	173	ON	Buffalo
Massena	72622 (94725)	44.9	-74.9	65	NY	Albany
International Falls	72747 (14918)	48.57	-93.37	359	MN	International. Falls

Note: All surface stations have an anemometer height of 10 m)

This Table contains seven columns and one header row. The first column lists the Surface Station Name; while the remaining columns list the corresponding ID, Latitude, Longitude, Height, Province (or State) where the station is located, and the UA (Upper Air) to be used respectively.

Table 6-5: Location of Upper Air Stations

UA station	ID	Latitude	Longitude
Buffalo	725280	42.93	-78.73
Maniwaki	7034480	46.23	-77.58
Albany	725180	42.75	-73.8
White Lake	726320	42.7	-83.47
Int. Falls	727470	48.57	-93.37

This Table contains four columns and one header row. The first column lists the UA (Upper Air) station, and the remaining columns list the corresponding station ID, Latitude, and Longitude respectively.

6.3.1 Regional Meteorological Data Processing Background

The original surface meteorological data was pre-processed by the MOE to reduce the amount of missing data and to use a minimum wind speed of about 1 m/s. Use of a 1 m/s minimum wind speed essentially eliminates missing hours due to calm

conditions. A calm is defined as a period where the wind speed is below the measurement threshold of the anemometer. During these periods, the data is often reported as missing, since both the wind speed and direction are either non-existent or highly uncertain. Atmospheric dispersion is typically quite poor during calm conditions, which can lead to elevated pollutant concentrations in the vicinity of a facility. As a result, the MOE regional data sets were processed using a specific methodology to remove the calms and set the wind speed to 1 m/s. Also, the wind directions during these periods were randomized to account for the variability in wind directions during these periods. This allows the model to calculate concentrations during these periods. The pre-processing steps were as follows:

Treatment of Wind Speed and Direction for Calm/Missing Conditions

Data sets that had approximately 5% or more missing or calm hours, were pre-processed by first filling these missing/calm hours with data from a nearby station with similar climatology. For example, missing/calm hours in the original International Falls and Massena data sets were filled by Kenora and Dorval data, respectively. Any remaining missing/calms hours (if less than 6 consecutive hours in a row) were then interpolated as described below, and the interpolated wind directions were randomized using a random number file, which is available on the MOE’s web site. Hours with calm or very low wind speeds were set to minimum speeds of 4 km/h (~1 m/s).

Interpolation of Missing Values

As indicated above, if missing hours remained after backfilling with data from another station, linear interpolation was applied to a maximum of six missing hours in a row. Note that missing data that occurred at the very beginning and at the very end of the data set (i.e., the first few hours in January of the first year of meteorological data, and the last few hours in December of the last year of meteorological data) were left as "missing", and no extrapolation was applied. Also, if the number of consecutive hours with missing values for the element was more than six, the entire block of values were left as "missing".

Unit Conversion

All data from Canadian sites were converted to the US standard format required for input into AERMET and PCRAMMET, as shown in Tables 6.1 and 6.2 presented earlier.

The MOE pre-processed data sets were run through PCRAMMET to generate the ISCPRIME ready regional meteorological data sets, whereas the AERMOD ready regional meteorological data sets were generated by the 3 stage AERMET process for three different wind independent surface categories, called “URBAN”, “FOREST” and “CROPS”. These three categories/files allow users to choose the file that most

accurately reflects the land use conditions in the vicinity of their site. For each of these three surface types, the MOE used a typical weighted average of surface parameters for each land use class considered in the category.

As indicated previously, the surface characteristics that are adjusted to reflect land use conditions are the albedo (A), the Bowen ratio (Bo) and the surface roughness (Zo). The parameter values used in each of the AERMOD ready regional files were derived from data in Tables 4.1, 4.2b (albedo for average conditions) and 4.3 of the AERMET User's Guide(6) and the weightings of different land uses considered in each file. These are shown in Table 6-6, Table 6-7, and Table 6-8 below for each category/file.

"URBAN" – all surface parameters were set to urban values, as in Table 6-6.

Table 6-6: Parameters for URBAN Surface Characteristics

SEASON	A	Bo	Zo
Winter	0.35	1.5	1
Spring	0.14	1	1
Summer	0.16	2	1
Fall	0.18	2	1

This Table contains four columns and one header row. The first contains each of the four seasons, and the remaining list the corresponding parameters.

"FOREST" – all surface parameters were set to the mixture of coniferous and deciduous forests in the ratio 50%/50% as in Table 6-7.

Table 6-7: Parameters for FOREST Surface Characteristics

SEASON	A	Bo	Zo
Winter	0.42	1.5	0.9
Spring	0.12	0.7	1.15
Summer	0.12	0.3	1.3
Fall	0.2	0.9	1.05

This Table contains four columns and one header row. The first contains each of the four seasons, and the remaining list the corresponding parameters.

"CROPS" – all surface parameters were set to the mixture of Grassland, Cultivated Land, and Coniferous and Deciduous forest in the ratio: 45%/45%/5%/5% as in Table 6-8.

Table 6-8: Parameters for CROPS Surface Characteristics

SEASON	A	Bo	Zo
Winter	0.6	1.5	0.095
Spring	0.16	0.35	0.15
Summer	0.19	0.65	0.265
Fall	0.19	0.85	0.13

This Table contains four columns and one header row. The first contains each of the four seasons, and the remaining list the corresponding parameters.

These AERMOD ready files may be used if the surface characteristics for a radius of 3 km around the facility match the surface characteristics of one of the prepared files. Note that the values in the above tables are somewhat different than those presented earlier in Tables 5.2 – 5.4, which were derived from information presented in the AERSURFACE User's Guide. The values in AERSURFACE represent a refinement over those in AERMET as there are 21 land use categories in comparison to the 8 in AERMET. The AERSURFACE data can be used in the development of local meteorological data sets where more detail may be necessary to accurately specify the land use patterns in the area. However, the regional meteorological data sets are intended to be somewhat generic, for use at a variety of locations in each region. As a result, MOE considers the use of the AERMET values in the regional data sets to be valid and representative.

In cases where the surface at a site do not match those defined in any of the AERMOD-ready regional meteorological data sets section 13(1)2 of the Regulation allows a proponent to use site specific surface conditions (i.e. local land use) in combination with the MOE's pre-processed surface and upper air data files in a Tier 2 assessment. In the Stage 3 processing of the meteorological data with AERMET, different surface characteristics may be entered on a variable sector size basis. The surface characteristics for each sector must be the weighted average for a radius of 3 km from the facility. The choice of surface characteristics (surrounding land use) must be well documented and provided as part of a proponent's submission (Section 26(1), paragraph 10 of the Regulation). Proponents must obtain approval from MOE (Environmental Monitoring and Reporting Branch (EMRB)) if values for the surface characteristics other than those in Tables 5.2 – 5.4 presented earlier are proposed for use.

6.3.2 Use of MOE Regional Meteorological Data

The application of the regional meteorological data sets across Ontario is described in Table 6-9: Application of Regional Meteorological Data Sets for MOE Regions and Districts

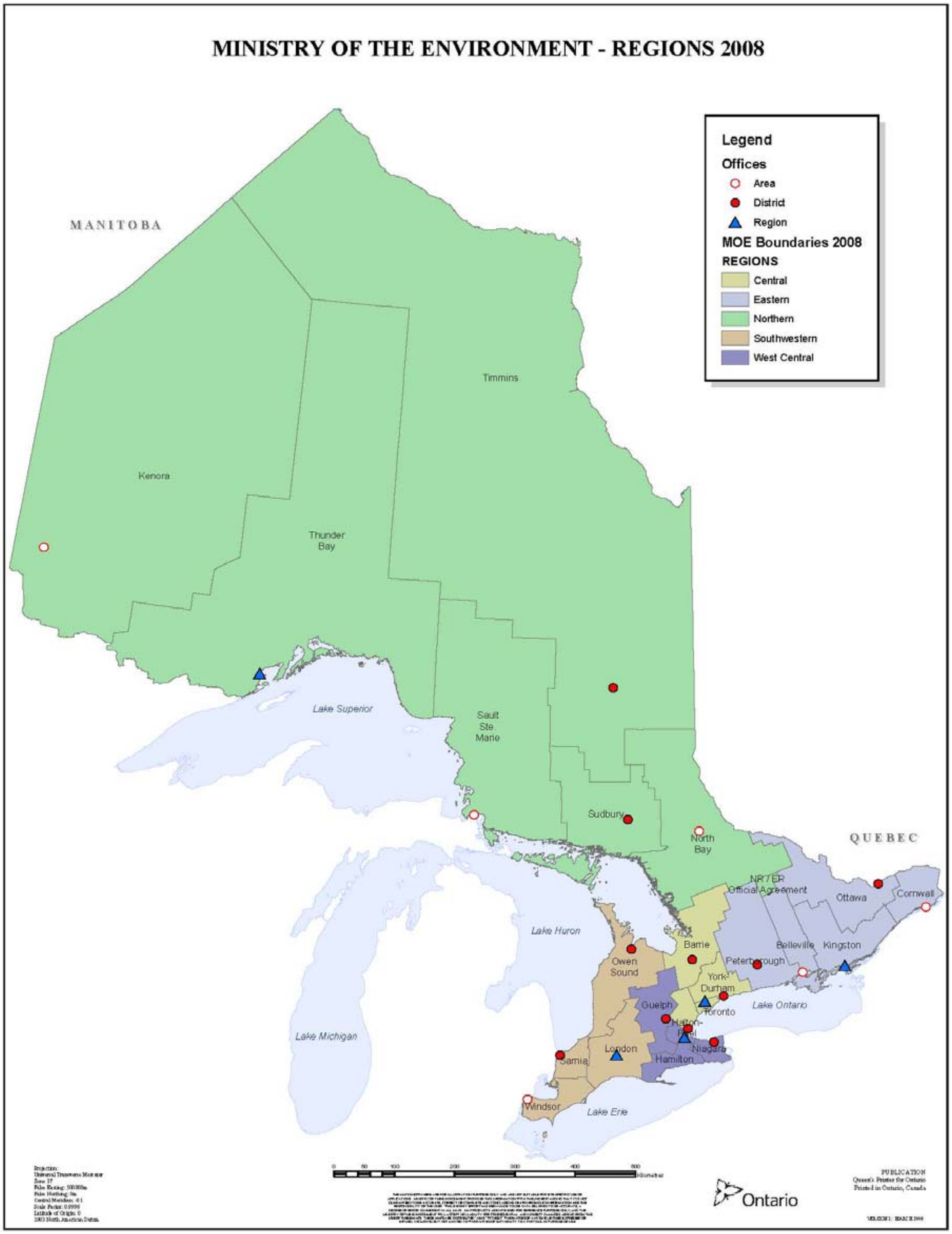
9. This table lists the MOE region and districts for which each of the meteorological data sets is most applicable. A map of the districts can be found in Figure 6.1.

Table 6-9: Application of Regional Meteorological Data Sets for MOE Regions and Districts

Meteorological Data Set	MOE Region	MOE District/Area
Toronto	Central	Toronto, York-Durham, Halton-Peel, Barrie, Owen Sound
London	Southwestern	London, Windsor, Sarnia
	West Central	Hamilton, Niagara, Guelph
Ottawa	Eastern	Ottawa, Peterborough, Belleville
Sudbury	Northern	Sudbury, North Bay, Sault Ste. Marie, Timmins
Int. Falls	Northern	Thunder Bay, Kenora
Massena	Eastern	Kingston, Cornwall

This Table contains three columns and one header row. The first columns lists the reference city for the Meteorological Data Set, while the remaining columns list the corresponding MOE Region and MOE District/Area.

Figure 6.1: Ontario Ministry of Environment Regions and Their Offices



In addition to the regional meteorological data sets given in Table 6.9, the MOE has processed data sets for a number of local sites across Ontario. These meteorological data sets are available from the MOE upon request.

6.4 Data Assessment: Reliability, Completeness and Representativeness

Meteorological data quality is of critical importance, particularly for reliable air dispersion modelling using models such as AERMOD. Meteorological data shall be processed and analyzed throughout the entire creation phase for completeness and quality control.

There are four factors that affect the representativeness of the meteorological data. These are: 1) the proximity of the meteorological site to the area being modelled; 2) the complexity of the terrain; 3) the exposure of the meteorological measurement site; and 4) the time period of the data collection. It should be emphasized that *representativeness* (both spatial and temporal) of the data is the key requirement. One factor alone should not be the basis for deciding on the representativeness of the data.

The meteorological data that is input to a model must be selected based on its appropriateness for the modelling project. More specifically, the meteorological data must be representative of the wind flow in the area being modelled, so that it properly represents the transport and diffusion of the contaminants being modelled. It should be noted that the Director may give notice to use a specific type of meteorological data where s/he is of the opinion that it accurately reflects meteorological conditions (see subsection 13(2) of the Regulation). Note that MOE approval must be obtained to use any site specific meteorological data set (see subsection 13(1), paragraphs 3 and 4 of the Regulation). A form is available on the MOE website at www.ene.gov.on.ca/envision/gp/5350e.pdf.

6.5 Expectations for Local Meteorological Data Use

No approval is required to use the appropriate regional meteorological data set. However, during modelling refinement it may be deemed that the regional meteorological data sets are not representative of the meteorology at the location of the facility. In such cases, the MOE may issue a notice under s.13(2) requiring the use of local meteorological data. Pre-processed local surface and upper air data may be obtained from the MOE, or raw meteorological data may be an appropriate Environment Canada site, on-site data or generated computationally through the use of an advanced meteorological model.

When using on-site or computationally generated data sets, the quality of the data, origin of the data and any processing applied to the raw data must be outlined for review by the MOE. Missing meteorological data and calm wind conditions can be

handled in an approach similar to that used for the generation of the regional meteorological data sets (described in Chapter 6.3.1). Proponents who wish to or who are required to use local or site specific meteorological data must obtain pre-approval by the MOE prior to the submission of an ESDM report. The necessary form is available on the MOE website at www.ene.gov.on.ca/envision/gp/5350e.pdf.

When Environment Canada sites are used as the source of local data, the MOE requires a description of why the Environment Canada site is representative for the facility and an assessment of the completeness of the data set. This information must be reviewed by the MOE before the proponent develops the local meteorological data set.

When on-site meteorological data is used, the sources of all of the data used to produce the meteorological file, including cloud data and upper air data must be documented. The proponent also needs to:

- describe why the site chosen is representative for the modelling assessment;
- include a description of any topographic impacts or impacts from obstructions (trees, buildings etc.) on the wind monitor;
- supply information on the heights that the wind is measured;
- supply the time period of the measurements; and
- supply the data completeness and the percentage of calm winds.

In preparing regional meteorological data sets, the MOE treated calms winds and missing data as described in Chapter 6.3.1. A discussion of the data Quality Assurance / Quality Control (QA/QC) methodology must be presented, along with the treatment of calm wind and missing data if local meteorological data is processed.

Wind roses showing the wind speed and directions shall be provided with the modelling assessment. If wind direction dependent land use was used in deriving the final meteorological file, the selection of the land use shall be documented as per Section 26(1) paragraph 10 of the Regulation. .

6.6 Elimination of Meteorological Anomalies

In modelling applications using regional or local meteorological data sets, certain extreme, rare and transient metrological conditions may be present in the data sets that may be considered outliers. As such, for assessments of 24 hour average concentrations, the highest 24-hour average predicted concentration in each single meteorological year may be discarded, and the MOE will consider for compliance

assessment the highest concentration after elimination of these five 24-hour average concentrations over the five year period from the modelling results.

For shorter averaging periods, such as 1 hour concentrations, the eight hours with the highest 1-hour average predicted concentrations in each single meteorological year may be discarded. The MOE will consider for compliance assessment the highest concentration after elimination of these forty hours over the five year period from the modelling results. This approach is for modelling results only (i.e. models with meteorological data inputs) and does not apply to measured or monitored concentrations. Note that the elimination of these anomalies is optional. Results will always be conservative if the meteorological anomalies are not eliminated.

Although some commercially available modelling software packages will select these values automatically, it can be done manually. If modelling using AERMOD or ISCPRIME, this approach can be applied by selecting the Maximum Values Table (MAXTABLE) option in the Output Pathway. A description of how the MAXTABLE could be used to eliminate meteorological anomalies is given in Appendix B.

7.0 RECEPTOR LOCATIONS

The ISCPRIME and AERMOD series of air dispersion models compute the concentrations of contaminants emitted from user-specified sources at user-defined spatial points. Modellers commonly refer to these points as receptors. These receptors are used in the modelling exercise to determine concentrations of contaminants at points of impingement as defined in s.2 of the Regulation. Proper placement of receptors is important to ensure that the location of the maximum POI concentration is determined. This can be achieved through several approaches. The types of receptors and receptor grids are described in Chapter 7.1, followed by a discussion in Chapter 7.2 on the grid extents and receptor densities required to capture maximum point of impingement concentrations as required by section 14 of the Regulation.

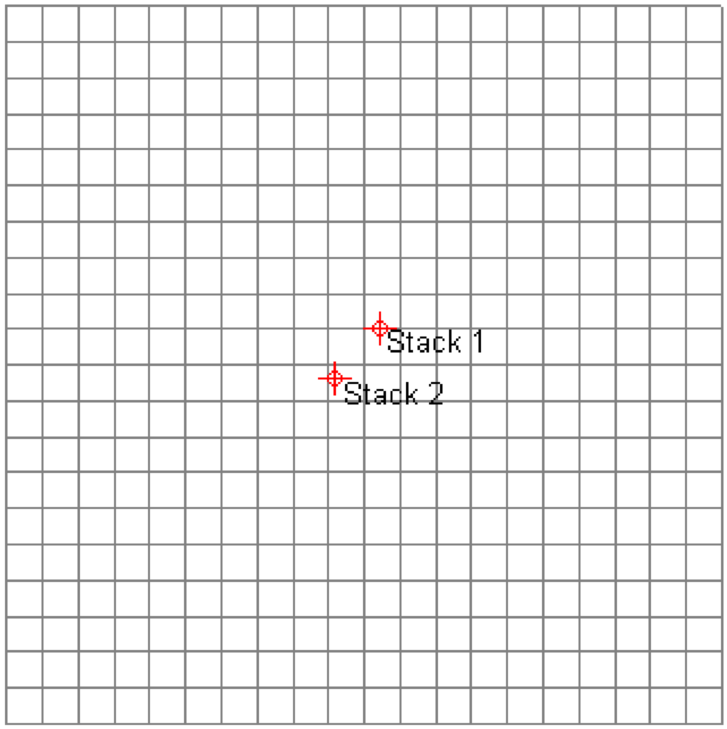
7.1 Receptor Types

Models such as AERMOD and ISCPRIME support a variety of receptor types that allow for considerable user control over calculating contaminant concentrations. The major receptor types and grid systems are described in the following subchapters. Further details on additional receptor types can be found in the appropriate documentation for each model.

7.1.1 Cartesian Receptor Grids

Cartesian receptor grids are receptor networks that are defined by an origin with evenly (uniform) or unevenly (non-uniform) spaced receptor points in x and y directions. Figure 7.1 illustrates a sample uniform Cartesian receptor grid.

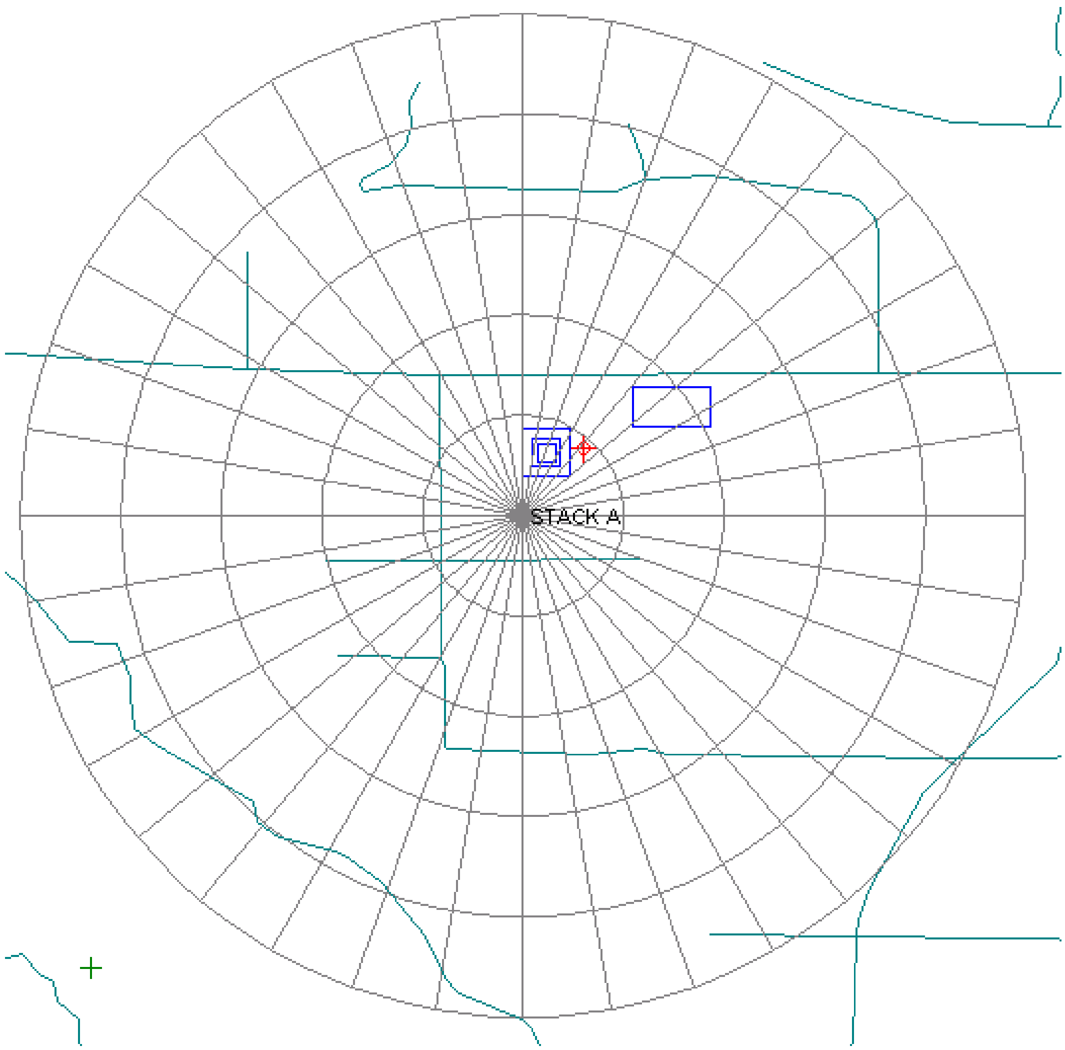
Figure 7.1: Example of a Cartesian Grid



7.1.2 Polar Receptor Grids

Polar receptor grids are receptor networks that are characterized by an origin with receptor points defined by the intersection of concentric rings, which have defined distances in metres from the origin, with direction radials that are separated by a specified degree spacing. Figure 7.2 illustrates a sample uniform polar receptor grid.

Figure 7.2: Example of a polar grid.



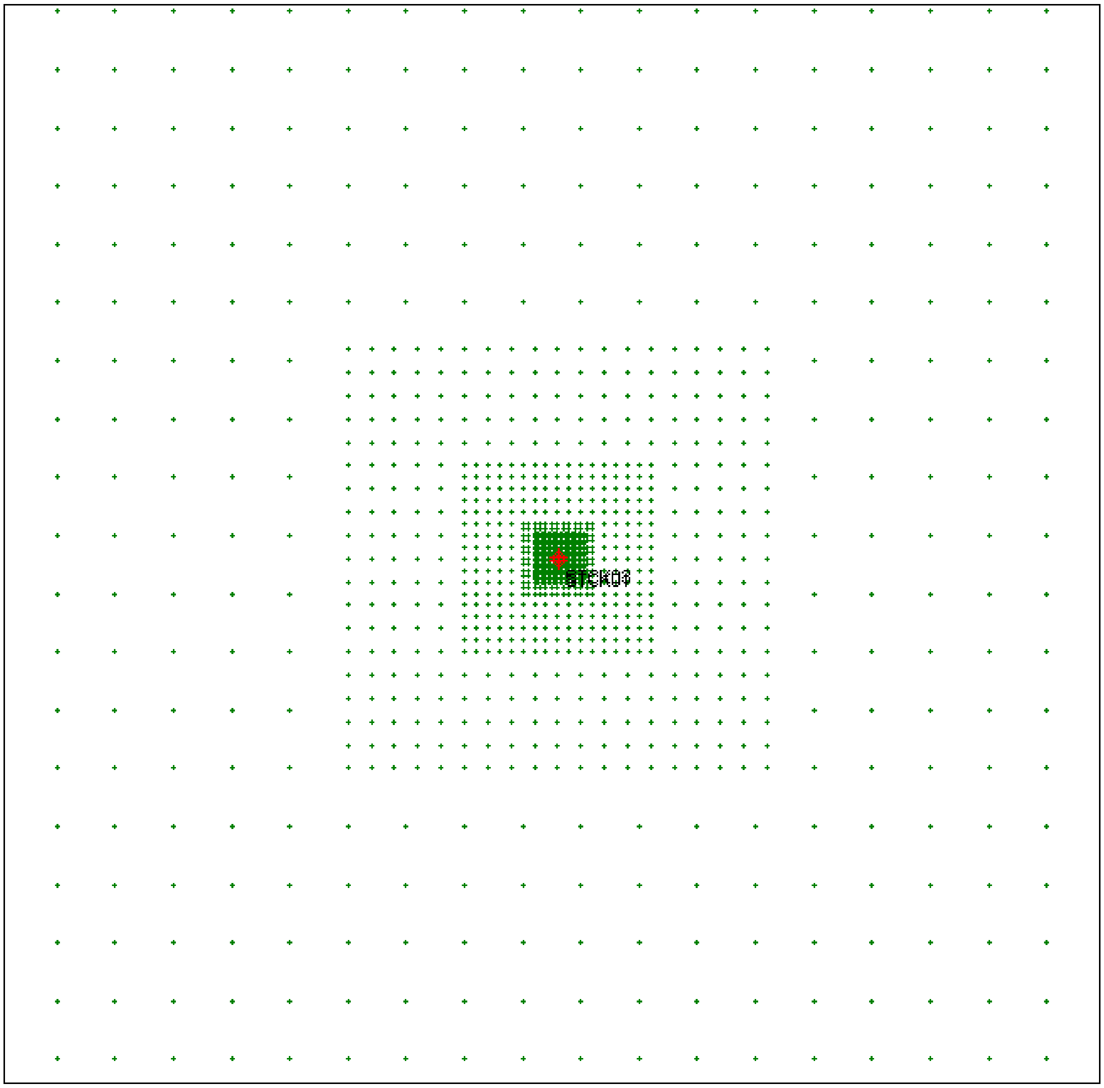
7.1.3 Multi-Tier Grids

Each receptor point requires computational time. Consequently, it is not optimal to specify a dense network of receptors over a large modelling area; the computational time would negatively impact productivity and available time for proper analysis of results. An approach that combines aspects of coarse grids and refined grids in one modelling run is the multi-tier grid.

The multi-tier grid approach strives to achieve proper definition of points of maximum impact while maintaining reasonable computation times without sacrificing sufficient

resolution. Figure 7.3 provides an example of a type of multi-tier grid that is required under section 14 (1) of the Regulation (see Section 7.2).

Figure 7.3: Sample Multi-Tier Grid Spacing with 5 tiers of Spacing



7.1.4 Fenceline Receptors

With the exception of same structure contamination and certain on-site receptors specified in section 2 of the Regulation, dispersion modelling for on-site receptors, or within the property boundary, is not normally required. As a result, property boundaries are typically delineated in projects and model results are not required within those areas. However, receptors must be placed along the plant boundary to demonstrate compliance at the nearest reportable geographical locations to the sources.

A receptor network based on the shape of the property boundary that has receptors parallel to the boundaries is often a good choice for receptor geometry. The receptor spacing can then progress from fine to coarse spacing as distance increases from the facility, similar to the multi-tier grid.

7.1.5 Discrete Receptors

Receptor grids do not always cover precise locations that may be of interest in modelling projects. Specific locations of concern such as a monitoring station or a residence can be modelled by placing single (discrete) receptors, or additional refined receptor grids, at desired locations. This enables the modeller to assess data on specific points for which accurate data is especially critical. In particular, concentrations of a contaminant at elevated points of impingement can be greater than concentrations found at ground level points of impingement. Depending on the project resolution and location type, elevated receptors can be characterized by discrete receptors, a series of discrete receptors, or an additional receptor grid.

Receptors of particular interest are set out in subsection 30(8) of the Regulation.

Under Section 30 of the Regulation – Upper Risk Thresholds:

"30 (8) The following places are the places referred to in subsection (7) and in subsection 32 (22):

1. ***A health care facility.***
2. ***A senior citizens' residence or long-term care facility.***
3. ***A child care facility.***
4. ***An educational facility.***
5. ***A dwelling.***
6. ***A place specified by the Director in a notice under subsection (9) as a place where discharges of a contaminant may cause a risk to human health.***

(9) For the purpose of paragraph 6 of subsection (8), the Director may give written notice to a person who is required to notify the Director under subsection (3) stating that the Director is of the opinion that the discharge may cause a risk to human health at a place specified in the notice."

7.2 Area of Modelling Coverage

Section 14 of the Regulation specifies the required area of coverage as follows:

Area of modelling coverage

14. (1) Subject to subsections (2) to (6), an approved dispersion model that is used for the purposes of this Part shall be used in a manner that predicts the concentration of the relevant contaminant at points of impingement separated by intervals of,

(a) 20 metres or less, in an area that is bounded by a rectangle, where every point on the boundary of the rectangle is at least 200 metres from every source of contaminant;

(b) 50 metres or less, in an area that surrounds the area described in clause (a) and that is bounded by a rectangle, where every point on the rectangle is at least 300 metres from the area described in clause (a);

(c) 100 metres or less, in an area that surrounds the area described in clause (b) and that is bounded by a rectangle, where every point on the rectangle is at least 800 metres from the area described in clause (a);

(d) 200 metres or less, in an area that surrounds the area described in clause (c) and that is bounded by a rectangle, where every point on the rectangle is at least 1,800 metres from the area described in clause (a);

(e) 500 metres or less, in an area that surrounds the area described in clause (d) and that is bounded by a rectangle, where every point on the rectangle is at least 4,800 metres from the area described in clause (a);

(f) 1,000 metres or less, in the area that surrounds the area described in clause (e).

Area of modelling coverage

(2) If an approved dispersion model is used for the purposes of this Part with respect to a property on which sources of contaminant are located and any point on the property boundary of the property is within 200 metres of any source of contaminant, the model shall be used in a manner that predicts the concentration of the relevant contaminant at points of impingement along the entire property boundary, and those points of impingement shall be separated by intervals of 10 metres or less.

(3) Subsection (1) or (2) does not apply if the approved dispersion model that is used is,

- ***(a) the ASHRAE method of calculation;***
- ***(b) the SCREEN3 dispersion model described in paragraph 4 of subsection 6 (1);***
- ***(c) the method of calculation required by the Appendix to Regulation 346; or***
- ***(d) a dispersion model or combination of dispersion models that, pursuant to subsection 7 (3), is deemed to be included in references in this Part to approved dispersion models, if the dispersion model or combination of dispersion models is not capable of predicting the concentration of the relevant contaminant at points of impingement described in subsection (1) or (2), as the case may be.***

(4). If an approved dispersion model is used for the purposes of this Part, it is not necessary to use the model in a manner that predicts the concentration of the relevant contaminant at a point of impingement if the distance from the property on which the sources of contaminant are located to that point of impingement is greater than the distance from the property on which the sources of contaminant are located to the point of impingement where, according to the model, the concentration of that contaminant would be highest.

(5) With respect to points of impingement on structures that are above ground level, an approved dispersion model that is used for the purposes of this Part shall be used in a manner that predicts the concentration of the relevant contaminant at a sufficient number of points of impingement on those structures to identify any points where discharges of the contaminant may result in an adverse effect or a contravention of section

18, 19 or 20.

(6) Despite subsections (1) to (5), the Director may give written notice to a person who discharges or causes or permits the discharge of a contaminant requiring that an approved dispersion model that is used for the purposes of this Part be used in a manner that predicts the concentration of the relevant contaminant at points of impingement described in the notice.

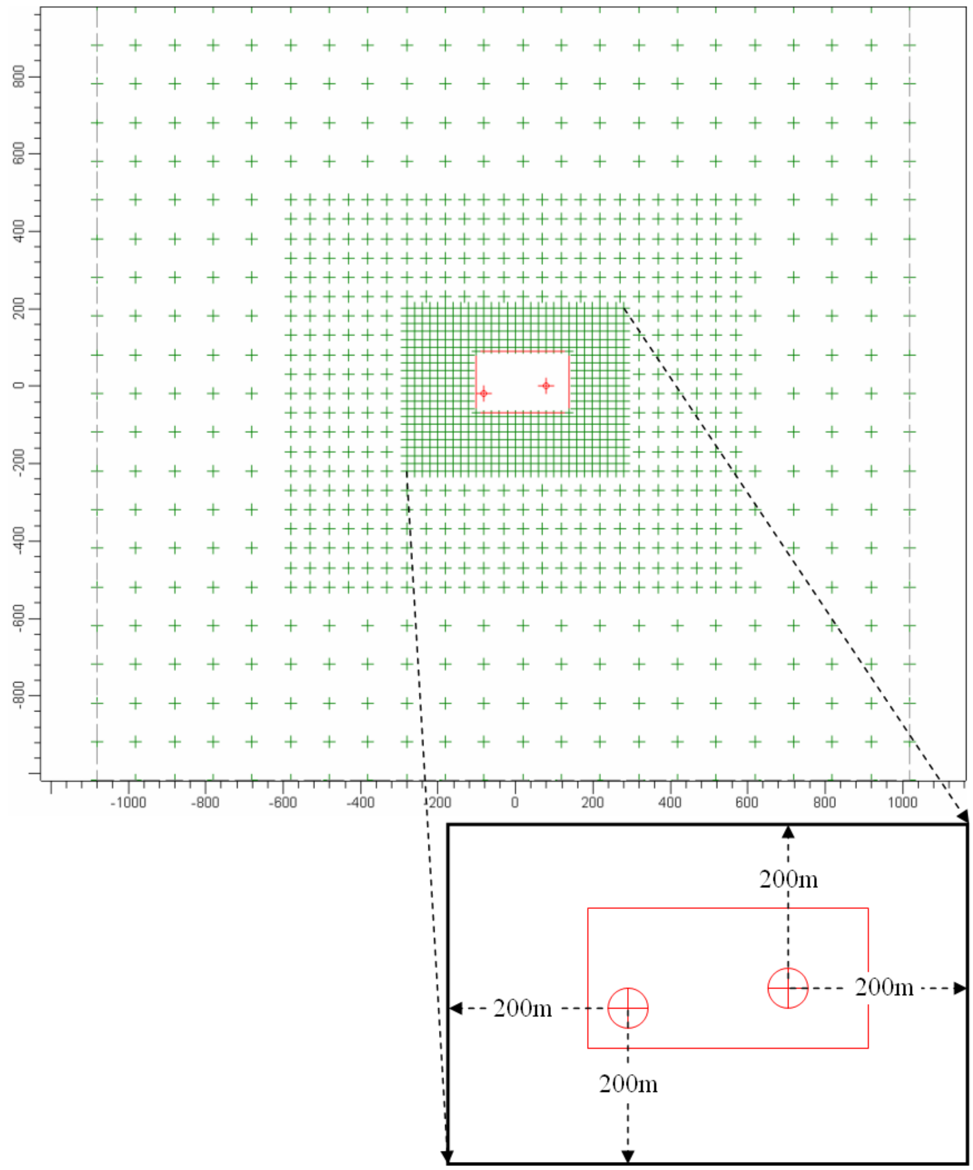
(7) Before the Director gives a person a notice under subsection (6), the Director shall give the person a draft of the notice and an opportunity to make written submissions to the Director during the period that ends 30 days after the draft is given

Subsection 14(4) requires that receptor definition must ensure coverage to capture the maximum contaminant concentration. For facilities with more than one emission source, the receptor network should include Cartesian or multi-tier grids to ensure that maximum concentrations are obtained. Screening model runs (i.e., SCREEN3, etc.) for the most significant sources on a facility can be used to determine the extent of the receptor grids. Tall stacks may require grids extending 20 to 25 km while ground level maxima for emissions from shorter stacks (10 - 20 m) might be obtained using grids extending a kilometre or less from the property line.

As set out in s.14(1), the densities of the receptors progress from fine resolution near the source, centroid of the sources, or most significant source (not from the property line) to coarser resolution farther away. Receptors shall be defined in a manner that predicts the concentration of the relevant contaminant at points of impingement separated by intervals that are consistent with the requirements specified in section 14 of the Regulation.

Figure 7.4 illustrates the application of the above receptor densities to a sample site.

Figure 7.4: Example of Multi-Tier Grid under the Regulation Showing Property Boundary



Subsection 14(2) requires that receptors shall also be placed along the entire property boundary, and shall be separated by intervals of 10 metres or less. Receptors are to be eliminated within the property boundary, as shown in Figure 7.4.

As set out in s.14(5), discrete receptors are required at locations where there are elevated points of impact such as apartment buildings and air intakes on nearby buildings. These are needed to ensure that maximum impacts are obtained. Other discrete receptors may be required for the types of receptors listed in subsection 30(8) of the Regulation.

The above are minimal requirements to aid the modeller in defining adequate receptor coverage. The final extent and details are the responsibility of the modeller who must demonstrate that the point of impingement where concentration of the contaminant is highest has been identified. Certain stack characteristics, such as tall stacks, may inherently require larger receptor coverage.

8.0 OTHER MODELLING CONSIDERATIONS

8.1 ASHRAE

The ASHRAE method of calculation is based on copyrighted equations that are available in the Chapter on building air intake and exhaust design in the ASHRAE HVAC Handbook. The equations are for assessing same building contamination only. Another approved dispersion model must be used to calculate the POI concentration at all other locations. The ASHRAE Handbook presents both a conservative screening and a more comprehensive methodology. Both methods calculate an initial plume spread followed by a further downwind dilution with the result being the number of times the concentration of contaminant in the exhaust flow is diluted by the time it reaches the intake.

The screening method conservatively assumes that the exhaust is located flush with the roof. The equation requires:

- the equivalent circular diameter of the exhaust;
- the exhaust exit velocity; and,
- the “stretched-string” distance between the nearest edge of the source release point and the nearest edge of the intake.

The equation is evaluated over a series of wind speeds and specific directions to determine the minimum dilution (maximum concentration).

The more comprehensive methodology breaks up the downwind dilution into a series of release regimes ranging from free standing stacks to flush vents. Refer to the ASHRAE Handbook for more details. The chapter on Building Air Intake and Exhaust Design can be purchased/downloaded at www.ASHRAE.org.

As discussed in Chapter 2.3.5, ASHRAE is required under section 9 of the Regulation for assessing same structure contamination once Section 20 applies to a facility.

8.2 Explanation for Alternative Model Use

Due to some limitations inherent in AERMOD and ISCPRIME (and most other plume models), there are some situations where the use of an alternative model may be appropriate. An alternative model may be requested by a facility or required by MOE. Acceptable Alternative Models and their use are further described in Appendix A.

AERMOD and ISCPRIME are a steady-state plume models. For the purpose of calculating 1-hour average concentrations, the plume is assumed to travel in a straight line without significant changes in stability as the plume travels from the source to a receptor. At distances on the order of tens of kilometres downwind, changes in stability, wind direction and wind speed are likely to cause this assumption to be invalid. For this reason, AERMOD and ISCPRIME shall not be used for modelling at receptors beyond 50 kilometres. AERMOD and ISCPRIME may also be inappropriate for some near-field modelling in cases where the wind field is very complex due to terrain or a nearby shoreline.

Neither AERMOD nor ISCPRIME treats the effects of shoreline fumigation. Shoreline fumigation may occur along the shore of an ocean or a large lake. When the land is warmer than the water, a sea breeze forms as the warmer, lighter air inland rises. As the stable air from over the water moves inland, it is heated from below, resulting in a turbulent boundary layer of air that rises with downwind distance from the shoreline. The plume from a stack source located near the shoreline may intersect the turbulent layer and be rapidly mixed to the ground, a process called "fumigation," resulting in high ground level concentrations. In these and other situations, the use of alternative models may be desired or required by the MOE.

The use of any alternative model requires approval by the MOE. The proponent must provide the MOE with the rationale for choosing a particular alternative model and demonstrate an understanding of the alternative model, its data requirements, and the quality of data required for the model. A form to request approval for an alternative model is available on the MOE web-site (www.ene.gov.on.ca/envision/gp/5352e.pdf). Use of alternative models is considered to be a Tier 3 modelling assessment and require pre-submission consultation and approval by the MOE.

Specified Dispersion Models

7. (1) The Director may give written notice to a person who discharges or causes or permits the discharge of contaminants from a property stating that the Director is of the opinion that, with respect to discharges of a contaminant from that property,

(a) one or more dispersion models specified in the notice would predict concentrations of the contaminant at least as accurately as an approved dispersion model;

(b) a combination specified in the notice of two or more dispersion models would predict concentrations of the contaminant at least as accurately as an approved dispersion model;

(c) a combination specified in the notice of one or more dispersion models and one or more sampling and measuring techniques would predict concentrations of the contaminant at least as accurately as an approved dispersion model; or

(d) one or more approved dispersion models specified in the notice would predict concentrations of the contaminant less accurately than,

(i) a dispersion model or combination specified under clause (a), (b) or (c), or

(ii) another approved dispersion model.

(2) Before the Director gives a person a notice under subsection (1), the Director shall give the person a draft of the notice and an opportunity to make written submissions to the Director during the period that ends 30 days after the draft is given.

(3) If a notice is given under subsection (1) with respect to discharges of a contaminant from a property, a reference in this Part to an approved dispersion model shall be deemed, with respect to those discharges,

(a) to include a dispersion model or combination specified under clause (1) (a), (b) or (c); and

(b) not to include a dispersion model that is specified under clause (1) (d).

(4) Subsection (3) applies in respect of all contaminants unless the notice given under subsection (1) provides that subsection (3) applies only in respect of contaminants specified in the notice.

(5) Subsection (3) does not apply to a discharge of a contaminant until,

(a) three months after the notice is given under subsection (1), unless clause (b) applies; or

(b) one year after the notice is given under subsection (1), if the notice includes a notice under clause (1) (c).

(6) Subsection (5) does not apply for the purpose of preparing a report to which subsection 22 (1.1) or (1.2), 23 (3), 24 (2), 30 (5) or 32 (16) applies.

(7) Subsection (5) does not apply to a discharge of a contaminant if subsection (3) would have the effect of permitting the discharge.

(8) If a notice is given to a person under subsection (1) and section 20 does not apply to the person in respect of a contaminant, subsection (3) applies to the person in respect of the contaminant only after section 20 begins to apply to the person in respect of the contaminant.

(9) Despite subsection (8), if a notice is given to a person under subsection (1) and section 20 does not apply to the person in respect of a contaminant, subsection (3) applies to the person in respect of the contaminant for the purpose of preparing a report to which subsection 22 (1.2), 23 (3), 24 (2), 30 (5) or 32 (16) applies.

(10) The Director may, by written notice, revoke a notice given under subsection (1).

(11) Subsection (3) ceases to apply to discharges of the contaminant three months after the notice is given under subsection (10). O. Reg. 419/05, s. 7 (11).

(12) Despite subsection (11), subsection (3) does not apply to a discharge of a contaminant after the notice is given under subsection (10) if subsection (3) would have the effect of prohibiting a discharge that would otherwise be permitted.

8.3 Use of Modelled Results in Combination with Monitoring Data

Monitoring and modelling should be considered complementary tools to assess potential impacts on the local community. If monitors measure accurately and are well located they can provide information on the magnitude and variability of a facility's emissions in addition to their potential impact. However, monitoring data is usually limited to a few locations and for a limited number of measurements which can bias the interpretation of the results. Conversely, modelling allows estimates of concentrations over a large number of receptors and a wide range of meteorological conditions. However, modelling results can also be biased by various factors including uncertainties or omissions in the quality of the emission data, or available information on local meteorological conditions. Using modelling results in combination with monitoring data provides a more complete and realistic analysis of the potential maximum POI concentrations.

The US EPA Guideline on Air Quality Models states that modelling is the approved method for determining concentrations and that monitoring alone would normally not be accepted. To assess compliance with MOE POI Limits, the MOE would consider model results along with monitoring data. Compliance shall not be demonstrated by monitoring information alone. If model results do not agree with measured data, a number of factors which could contribute to the disagreements shall be considered. For example, the facility's source characteristics and emission data are factors which

shall be reviewed. The adequacy of the locations and amount of monitoring data along with the data accuracy shall also be considered. For more information on combined modelling/monitoring analysis and the requirements of the Regulation, see the ESDM Procedure Document and sections 10, 11, and 12 of the Regulation.

The use of a combination of modelling and monitoring data to determine facility emission rates is required by Section 12(1) of Ontario Regulation 419 unless certain conditions are met. Where this approach is used, monitoring data is compared to model results at monitoring locations impacted by facility emissions. The source emission rates are then scaled upward or downward and re-modelled in an iterative process until the modelled results match the monitoring data. In this manner, emissions are "refined" such that potential biases (high or low) in the estimates are identified, in addition to inherent variability that may not have been previously characterized or understood. Appendix E of the ESDM Procedure Document should be consulted for further guidance and details on this approach.

Decisions on the adequacy of the monitoring data will be made on a case-by-case basis in consultation with the MOE. Pre-consultation with the MOE is required if a comparison of model results with monitoring data is undertaken for compliance assessment purposes. A form is available on the MOE website at www.ene.gov.on.ca/publications/6323e.pdf.

For cases where reliable information is available on the emission rates and source characteristics for a facility, modelled results can identify maximum impact areas and concentration patterns that could assist in locating monitoring sites. Model runs using a number of years of meteorological data would show the variations in the locations and the magnitude of maximum concentrations. Modelling results can also be used to provide information on the frequency of exceedences of high concentrations but only when used with more site specific meteorological conditions. For more information, see the "*Guideline for the Implementation of Air Standards in Ontario*" (GIASO).

8.4 Determination of Frequency of Exceedence

There are several circumstances when determination of the frequency of a certain concentration being exceeded may be required. Two situations are when an Upper Risk Threshold is being exceeded and when a facility is making a request for an Alternative Air Standard. For example, Section 30(7) paragraph 3 (upper risk thresholds) and Section 32(13) paragraph 2(iii) (alternative standard request) state the following:

> *"A ...statement specifying the number of averaging periods for which the approved dispersion model predicts that discharges of the contaminant may result in a contravention of section 20 because of the concentration of the contaminant at the point of impingement, expressed as a percentage of the number of averaging periods…."*

The use of a local representative meteorological data set and a refined emission inventory that uses variable emissions (if applicable) are important if the frequency results are to be representative. The MOE regional data sets may not be used to determine frequency of exceedence without prior approval from the MOE.

There are a couple of different ways to obtain frequency information. Using the MAXIFILE keyword in the model OUTPUT Pathway creates a file that lists, in date order, the concentrations that are above a threshold (i.e. a POI Limit) for each grid point. This allows one to calculate the frequency of exceeding a particular threshold concentration. The POSTFILE keyword in the OUTPUT Pathway allows one to obtain all modelled concentrations for each receptor. Note that a POSTFILE can get very large. The frequency analysis should be determined at every receptor that is over a MOE POI Limit. It should be noted that the maximum concentration grid point is not necessarily the location of the highest frequency of exceedences).

8.5 Modelling Adjacent Properties

Section 4 of the Regulation sets out the conditions where, for the purpose of compliance with MOE POI Limits, two or more adjacent properties would be considered to be a single property. In these cases, the aggregate emissions from each of the adjacent properties would be considered together, and the site/facility can be defined by the external property line around the group of adjacent properties.

Adjacent Properties

4. (1) Two properties are adjacent for the purposes of this Regulation if the boundary of one property touches or, were it not for an intervening highway, road allowance, railway line, railway allowance or utility corridor, would touch the boundary of the other property,

(2) For the purposes of this Regulation, except section 34, two or more properties on which different sources of contaminant are located shall be deemed to be a single property if each of the properties is adjacent to one or more of the other properties and,

- ***a. the persons responsible for the sources of contaminants have jointly notified the Director in writing that they wish the properties to be deemed to be a single property;***
- ***b. the Director has reasonable grounds to believe that a contravention of section 18, 19, or 20 may occur as a result of discharges of a contaminant from the different sources of contaminant if the properties are deemed to be a single property, and the Director has given written notice of that belief to the persons responsible for the sources of contaminant;***
- ***(b.1) the persons responsible for the sources of contaminant are required to prepare a report to which subsection 22(1.1) applies, the Director has reasonable grounds to believe that a contravention of section 19 may occur as a result of the discharges of a contaminant from the different sources of contaminant if section 19 applies and the properties are deemed to be a single property, and the Director has given written notice of that belief to the persons responsible for the sources of contaminant; or***

(c) the persons responsible for the sources of contaminant are required to prepare a report to which subsection 22(1.2), 23(3), 24(2), 30(5) or 32(16) applies, the Director has reasonable grounds to believe that a contravention of section 20 may occur as a result of the discharges of a contaminant from the different sources of contaminant if section 20 applies and the properties are deemed to be a single property, and the Director has given written notice of that belief to the persons responsible for the sources of contaminant

(2.1) Subject to subsection (2.2), clause (2)(a) does not begin to apply until 60 days after the Director receives the notice referred to in that clause.

(2.2) Clause (2)(a) does not apply if the Director has reasonable grounds to believe that an adverse effect may occur if one or more of the properties are excluded form the single property and gives written notice of that belief to the persons responsible for the sources of contaminant.

(2.3) The Director shall not give a person a notice under subsection (2.2) unless the Director first gives the person a draft of the notice and an opportunity to make written submissions to the Director during the period than ends 30 days after the draft is given.

(3) Before the Director gives a person a notice under clause (2)(b), (b.1) or (c), the Director shall give the person a draft of the notice and an opportunity to make written submissions to the Director during the period that ends 30 days after the draft is given.

(4) Subsection (2) applies only if every property on which a source of contaminant is located,

(a) uses raw materials, products or services from one or more of the other properties on which the sources of contaminant are located; or

(b) provides raw materials, products or services to one or more of the other properties on which the sources of contaminant are located.

(5) Clause (2)(c) only applies for the purpose of preparing the report referred to in that clause.

9.0 GLOSSARY OF TERMS

AERMAP: The terrain pre-processor for AERMOD. AERMAP allows the use of digital terrain data in AERMOD.

AERMET: The meteorological pre-processor for AERMOD.

AERMIC: **A**merican Meteorological Society/**E**nvironmental Protection Agency **R**egulatory **M**odel **I**mprovement **C**ommittee.

AERMOD: The current US EPA short-range regulatory air dispersion model that was developed by AERMIC. AERMOD is a next-generation air dispersion model that incorporates concepts such as planetary boundary layer theory and advanced methods for handling complex terrain.

Air Emissions: Release of contaminants into the air from a source of contaminant.

Albedo: Portion of the incoming solar radiation reflected and scattered back to space.

Alternative Model: is a model approved for use in Ontario as set out in s.7 of the Regulation, that may be used if conditions warrant their use and are approved by the MOE, and may be used instead of or to complement MOE's list of approved models.

Ambient Air (Air): Open air not enclosed in a building, structure, machine, chimney, stack or flue.

AMS: American Meteorological Society.

Approved Dispersion Models: means a model listed in section 6 of the Regulation or approved under s.7 of the Regulation.

> ***6.*** *(1) For the purposes of this Part, the following are approved dispersion models for discharges of a contaminant, except as otherwise provided:*
>
> 1. The AERMOD dispersion model made available on the Internet by the United States Environmental Protection Agency, as amended from time to time, or a copy of that model that is available from the Ministry.
>
> 2. The ASHRAE method of calculation.

3. The ISCPRIME dispersion model made available on the Internet by the United States Environmental Protection Agency, as amended from time to time, or a copy of that model that is available from the Ministry.

4. The SCREEN3 dispersion model made available on the Internet by the United States Environmental Protection Agency, as amended from time to time, or a copy of that model that is available from the Ministry.

5. The method of calculation required by the Appendix to Regulation 346, if section 18 or 19 applies to the discharges. O. Reg. 516/07, s. 3.

(2) The Ministry shall make copies of the approved dispersion models referred to in paragraphs 1, 3, 4 and 5 of subsection (1) available through a website maintained by the Ministry on the Internet or through the Ministry's Public Information Centre. O. Reg. 516/07, s. 3.

Calm: Cessation of horizontal wind.

Complex Terrain: Terrain exceeding the height of the stack being modelled.

DEM – Digital Elevation Model. Digital files that contain terrain elevations typically at a consistent interval across a standard region of the Earth's surface.

Dispersion Model: A group of related mathematical algorithms used to estimate (model) the dispersion of contaminants in the atmosphere due to transport by the mean (average) wind and small scale turbulence.

Diurnal: Daytime period.

Emission Factor: Typically used with a product production rate or a raw material consumption rate to assess the rate at which a contaminant is released to the atmosphere.

ESDM Report: Emission Summary and Dispersion Modelling Report (see also section 26 of the Regulation).

Flagpole Receptor: Any receptor located above ground level (see subsection 14(5) of the Regulation).

Inversion: An increase in ambient air temperature with height. This is the opposite of the usual case.

ISCPRIME: The US EPA Industrial Source Complex – Short Term Dispersion Model supporting the PRIME downwash algorithms.

Lee side: The lee side of a building is the side that is sheltered from the wind.

Mixing Height: Top of the neutral or unstable layer and also the depth through which atmospheric contaminants are typically mixed by dispersive processes.

MOE or Ministry: the Ontario Ministry of the Environment.

Monin-Obukhov Length: A constant, characteristic length scale for any particular example of flaw. It is negative in unstable conditions (upward heat flux), positive for stable conditions, and approach infinity as the actual lapse rate for ambient air reaches the dry adiabatic lapse rate.

NWS: National Weather Service. A U.S. government organization associated with the National Oceanic and Atmosphere Administration.

Pasquill Stability Categories: A classification of the dispersive capacity of the atmosphere, originally defined using surface wind speed, solar insolation (daytime) and cloudiness (night time). They have since been reinterpreted using various other meteorological variables.

PCRAMMET: Meteorological program used for regulatory applications capable of processing twice-daily mixing heights (TD-9689 FORMAT) and hourly surface weather observations (CD-144 format) for use in dispersion models such as ISCPRIME, CRSTER, MPTER and RAM.

Regulation: means Ontario Regulation 419/05: Air Pollution - Local Air Quality

Regulatory Model: A dispersion model that has been approved for use by the regulatory offices of the US EPA, specifically one that included in Appendix A of the Guideline on Air Quality Models (Revised).

Screening Technique: A relatively simple analysis technique to determine if a given source is likely to pose a threat to air quality. Concentration estimates from screening techniques are conservative.

Simple Terrain: An area where terrain features are all lower in elevation than the top of the stack of the source.

Upper Air Data (or soundings): Meteorological data obtained from balloon-borne instrumentation that provides information on pressure, temperature, humidity and wind away from the surface of the earth.

US EPA: United States Environmental Protection Agency (U.S. EPA).

Wind Profile Component: The value of the exponent used to specify the profile of wind speed with height according to the power law.

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APPENDIX A

ALTERNATIVE MODELS

APPENDIX A: ALTERNATIVE MODELS

1.0 ACCEPTABLE ALTERNATIVE MODELS

The following list contains alternative models that are currently accepted by the Ministry of Environment (MOE) for site specific consideration.

- CALPUFF
- CAL3QHCR
- SDM – Shoreline Dispersion Model
- Physical Modelling

If a proponent is required to use or requests to use an alternative model, it would be considered a Tier 3 modelling assessment and is subject to approval by the MOE. A Notice from the Director specifying use of an alternative model is required. Pre-submission consultation is required for Director approval (see Section 7 of the Regulation). A form is also available for this request.

2.0 ALTERNATIVE MODEL USE

2.1 Use of CALPUFF

CALPUFF(34) is a puff model that is capable of fully accounting for hour-by-hour and spatial variations in wind and stability. Puff models, in general, perform well at downwind distances from a few kilometres to more than 100 km. CALPUFF contains additional algorithms that allow it to emulate AERMOD (or ISCST3) at short distances where puff models are generally less reliable. Further, CALPUFF has been evaluated and found to be reasonably accurate at distances up to 300 km. Thus, CALPUFF can be recommended for use for all distances up to 300 km. CALPUFF is particularly useful in modelling situations that involve long-range transport (up to 300 km, light wind and calm conditions, wind reversals such as land–sea (or lake) breezes and mountain–valley breezes, and complex wind situations found in very rugged terrain). The decision as to whether the use of CALPUFF is justified requires competent meteorological judgment. There are no hard and fast rules that can be applied.

CALPUFF is a more complex model with increased meteorological data requirements.

2.2 *Use of CAL3QHCR*

CAL3QHCR(35,36) is a roadway dispersion model that can process a year of hourly meteorological data, with corresponding emissions, traffic and intersection signalization data. CAL3QHCR is particularly recommended for modelling of intersections. At signalized intersections, it accounts for idling emission rates from vehicles. CAL3QHCR calculates the concentrations in the vicinity of a roadway or intersection at averaging times from 1 hour to annual. CAL3QHCR can accommodate up to 120 “links,” including both free-flowing roads and signalized intersections, and predict concentrations of carbon monoxide (CO), particulates (PM) and other inert contaminants within a few kilometres of the roadway. Its regulatory use in the U.S. is for CO concentrations near roads and intersections.

A link may constitute a (nearly) straight section of road, a signalized intersection, a bridge, an elevated road on fill, or a cut (depressed) roadway. A curved road can be represented as a series of links. Traffic data can be either as a general function of hour-of-day and day-of-week, or every hour of the year, depending on the detail required. CAL3QHCR is particularly useful when the worst case meteorological conditions are not known in advance, requiring a year of meteorology to be run to identify a worst case. It is also useful for obtaining averaging times longer than 1 hour (e.g., 8-hour, 24-hour, etc.) directly from the computations, without the need for conservative averaging time conversions.

CALINE4(37) is another roadway model designed to calculate a single 1-hour average concentration for a defined single hour of meteorological data for local roadways including intersections. This is most useful when a worst-case 1-hour meteorology (e.g. light wind parallel to the roadway) is known. If a worst case meteorology is not known, or direct calculation of longer averaging times is required, the CAL3QHCR model would be a better choice.

2.3 *Use of Shoreline Dispersion Model*

SDM (Shoreline Dispersion Model(38)) can calculate a year or more of hourly concentrations calculating the effect of shoreline fumigation on plumes from stack sources at a shoreline due to shoreline fumigation when that event is likely to occur. At other times, it calculates concentrations based on a standard Gaussian plume model. SDM is relatively easy to use, and is appropriate for sources located at a shoreline. The data requirements and ease of use are typical of Gaussian plume models. More complicated situations may require the use of CALPUFF which requires more time and data.

2.4 *Use of Physical Modelling*

Physical modelling is a term that comprises modelling in a wind tunnel or water channel. Some situations are so complex that the available computer models cannot be relied upon. In such cases, the use of physical modelling may be considered. Physical modelling is without question the most costly of any modelling approach. Further, it can account for only one meteorological event at a time. Often, only neutral and stable conditions can be modelled. Even with these limitations, physical modelling can provide useful information for complex situations that cannot be reliably modelled by computer models.

3.0 EXPLANATION OF USE REQUIREMENTS

3.1 *CALPUFF*

CALPUFF should be run using input data from three or more surface and upper air meteorological stations, as a minimum. In addition, output from the MM5 prognostic atmospheric model may be used to improve CALPUFF performance. Running CALPUFF in one of its screening modes, or with a single meteorological data source, defeats the benefits of CALPUFF's ability to account for spatial variations in the wind field. It still accounts for time variations in wind and stability, however, so there may, in some few cases, be a benefit in running CALPUFF in this mode. It should, however, be run using several meteorological stations in the majority of cases.

Whenever possible, five years of meteorological data should be used to drive CALPUFF. However, if adequate data is sparse a shorter period of data may be used (subject to approval). Under no conditions should less than one year of data be used. Further, if there are breaks in the meteorological data, care should be taken that all months are adequately represented so that seasonal variations in meteorology are adequately accounted for.

CALPUFF also requires files of terrain and land use data.

CALPUFF has a large number of input options available. The use of alternative models must be acceptable to the Director. An applicant must consult with the MOE prior to submitting modelling results using CALPUFF. This will determine the current recommendations for the input options to be used, as well as the selection of meteorological data to be used. In general, the recommendations of the Interagency Workgroup on Air Quality Modelling (IWAQM) Phase 2 report(39), or any more recent recommendations, should be followed. The IWAQM recommendations notwithstanding, the MPDF option should be set to "1," i.e., "yes," so that CALPUFF

will emulate AERMOD in the near field. The MPDF in CALPUFF selects the use of a probability density function (pdf) instead of a Gaussian function to describe the contaminant distribution through the plume in the vertical during convective (i.e., unstable) conditions for near-field calculations. This is the approach used in AERMOD.

Applicants that intend to run CALPUFF themselves are required to have a written agreement with the MOE on the options to be set and the meteorological data to be used. The use of the model must be acceptable to the Director.

3.2 *CAL3QHCR*

CAL3QHCR(40) requires one year of meteorological data pre-processed using MPRM, RAMMET or PCRAMMET. If possible, CAL3QHCR should be run for five years of meteorology. If on-site data are used, this requirement may be relaxed. In the US EPA Regulations, one year of on-site data is acceptable. In no case should less than one year of data be used. In the case of data sets from a broken period of record, care should be taken that all months of the year are adequately represented so that seasonal changes are properly accounted for. In addition, surface roughness coefficients (derived from land use information), and, for modelling particulates, settling and deposition velocities are also required.

CAL3QHCR can model up to 120 links and 60 receptors. Each link must be defined with Cartesian coordinates of the endpoints of each link and coordinates of each of the receptors.

Traffic variables required by the model include the following:

- traffic volume for each link (vehicles per hour);
- traffic speed for each link (miles per hour);
- average signal cycle length for each intersection (seconds);
- average red light time length for each approach (seconds);
- clearance lost time (seconds);
- saturation flow rate (vehicles per hour);
- signal type (pre-timed, actuated, or semi-actuated); and
- arrival rate (worst, below average, average, above average, best progression).

Traffic volumes may, optionally, be input as a function of hour-of-day and day-of-week to give more realistic modelling results. In cases where diurnal and weekly traffic patterns are different during one season than another, CAL3QHCR would be run during each season separately with the appropriate pattern.

Emission variables required by CAL3QHCR include the following:

- Composite running emission factor for each free flow link (grams per vehicle-mile); and
- Idle Emission Factor for each queue link (grams per vehicle-hour).

3.3 *Shoreline Models*

In situations where shoreline affects the meteorology of the area significantly, CALPUFF would be the model of choice. However, CALPUFF requires substantial resources in terms of data, computer power and time. In the case where the dominant sources are located on a shoreline, and other sources in the area are clearly secondary, the SDM (Shoreline Dispersion Model[38]) may be used. SDM is a far simpler and less costly model to use than CALPUFF. It is a matter of professional judgement as to when shoreline effects are sufficient to warrant a shoreline model. For this reason, and for the reason that the model of choice may be a costly model to run (CALPUFF), it is important that an agreement is reached between the MOE and the applicant before modelling using an alternate model is initiated.

3.4 *Line Source/ Traffic Dispersion Models*

If roadway contributions to concentrations in a specific area are clearly secondary, traffic emissions can be adequately included in AERMOD or CALPUFF modelling of a region. This may be the case for particulate matter. In this case, traffic sources may be treated as area sources (if their impact is minimal) or as elongated area sources (in AERMOD) or line sources (in CALPUFF) if the impacts of individual streets or roads are more significant. If the local increase in concentrations of a proposed road or expansion of a road (e.g., adding more lanes with higher expected traffic volume) is proposed, CALINE-4 or CAL3QHCR can be used to assess the effects of the proposed road or expansion alone. This would be appropriate if existing concentrations of a contaminant from other sources (e.g., CO) are either low or are well defined. If a “worst case” meteorology is defined (e.g., one metre per second wind speed parallel to the roadway, at F stability), then CALINE-4 can be used to predict the worst case 1-hour average concentration. This can be used as a screening estimate of maximum concentrations at longer averaging times (e.g., 8-hour, 24-hour) by applying averaging time conversion factors. However, more refined modelling for longer averaging times must be accomplished using

CAL3QHCR when the road traffic emissions dominate the concentrations. This is especially the case for carbon monoxide (CO).

Appendix A. ELIMINATION OF METEOROLOGICAL ANOMALIES (AN EXAMPLE)

AN EXAMPLE CASE STUDY FOR THE ELIMINATION OF METEOROLOGICAL ANOMALIES FROM THE MAXIMUM VALUES TABLE FOR 1HR AND 24HR AVERAGED CONCENTRATIONS

APPENDIX B. ELIMINATION OF METEOROLOGICAL ANOMALIES

In this Appendix, an example of the methodology for the elimination of meteorological anomalies is presented. Note that the elimination of these anomalies is optional: results will always be conservative if the meteorological anomalies are not eliminated.

Figure B.1 contains a sample AERMOD Output Pathway definition, and the four bolded lines were added to generate the MAXTABLE option. The MAXTABLE as specified below will give the top 100 modelled values across the entire modelling domain.

Figure B.3.1: Selecting the MAXTABLE Option in AERMOD

```
****************************************

** AERMOD Output Pathway

****************************************

**

OU STARTING

   RECTABLE ALLAVE 1ST

   RECTABLE 1 1ST

   RECTABLE 24 1ST

   MAXTABLE ALLAVE 100

** Auto-Generated Plotfiles

   PLOTFILE 1 ALL 1ST file.AP\01H1GALL.PLT

   PLOTFILE 24 ALL 1ST file.AP\24H1GALL.PLT

OU FINISHED
```

Once the model run is complete, a listing of the ranked concentrations can be retrieved from the model output file. Sample excerpts of an AERMOD output file are shown in Table B.1. and Table B.2., which contain a portion of the Maximum Value tables of ranked 1st to 80th for the 1-hr and 24-hr concentrations respectively. The following example illustrates the elimination of meteorological anomalies from the

maximum values table for 1hr and 24hr averaged concentrations, and the identification of the final concentrations (or compliance points).

Step 1: Open the AERMOD output file using a text editor;

Step 2: Locate the 1-hr Maximum Values Table ("THE MAXIMUM 100 1-HR AVERAGE CONCENTRATION VALUES"), and print the number of pages containing the data (~4 pages). A sample excerpt is shown in Table B.1..

Step 3: The first column of the table shows the Rank (starting with 1); the second column shows the concentration; and the third column identifies the meteorological date and time of occurrence (first two digits designate the year). For each meteorological year, cross out the eight hours with the highest 1-hr concentrations starting from the beginning of the table. From Table B.1. the following hours can be eliminated:

```
1996 Rank:  3,  7,  9, 45, 47, 61, 68, 70 & 77

1997 Rank:  2,  6,  8, 22, 43, 46, 49, 56

1998 Rank:  5, 14, 19, 20, 23, 24, 28, 31

1999 Rank:  1,  4 & 5, 10, 11, 12, 16, 18, 26

2000 Rank: 13, 15, 17, 21, 25, 27, 29, 32
```

Note that the 4^{th} and the 5^{th} highest ranked concentrations occurred at different locations but in the same hour and thus both are eliminated. This also occurs for the 70^{th} and 77^{th} highest ranked concentrations.

Step 4: Once the total of forty 1-hr periods have been eliminated from the five year data set, the final concentration would be the remaining highest ranking concentration in the table – in this example, the final concentration is 62.98217 which is ranked 30^{th} highest overall and occurs in 1999.

Step 5: Similarly, from the 24-hr Maximum Values Table (Table B.2.), cross out the highest 24-hr concentration for each meteorological year starting from the beginning of the table. From Table B.2., the following 24-hr periods can be eliminated: 1996 Rank 22; 1997 Rank 4; 1998 Rank 1 and Rank 18; 1999 Rank 9; 2000 Rank 6 as shown in the table below. For 1998, both Rank 1 and Rank 18 occur on the same day (at different locations) and thus both are eliminated since this is considered one meteorological anomaly.

Step 6: Once the total of five 24-hr periods have been eliminated, the final concentration for modelling would be the remaining highest ranking concentration in the table – in this example, the final concentration is 47.52893 which is ranked 2nd highest and occurs in 1998.

Table B.1.: Maximum 100 1-Hr Average Concentration Values (only 80 shown; compliance point block-highlighted)

RANK	CONC	(YYMMDDHH)	AT RECEPTOR(XR,YR)	OF TYPE	RANK	CONC	(YYMMDDHH)	AT RECEPTOR(XR,YR)	OF TYPE
1.	~~**65.10020**~~	(99061006)	AT (-100.00, 0.00)	DC	41.	62.82240	(00101302)	AT (100.00, 0.00)	DC
2.	~~**64.53565**~~	(97120410)	AT (100.00, 0.00)	DC	42.	62.80699	(00042122)	AT (0.00,-100.00)	DC
3.	~~**64.34751**~~	(96012310)	AT (0.00,-100.00)	DC	43.	~~**62.80058**~~	(97012722)	AT (0.00, 100.00)	DC
4.	~~**64.13493**~~	(99071606)	AT (100.00, 0.00)	DC	44.	62.79989	(99102108)	AT (100.00, 0.00)	DC
5.	~~**64.05058**~~	(98071606)	AT (100.00, 100.00)	DC	45.	~~**62.79814**~~	(96091420)	AT (0.00, 100.00)	DC
6.	~~**63.89120**~~	(97082119)	AT (100.00, 0.00)	DC	46.	~~**62.78178**~~	(97012124)	AT (0.00, 100.00)	DC
7.	~~**63.77862**~~	(96062920)	AT (0.00, 100.00)	DC	47.	~~**62.78073**~~	(96120821)	AT (100.00, 0.00)	DC
8.	~~**63.76183**~~	(97081219)	AT (-100.00, 0.00)	DC	48.	62.77896	(99060906)	AT (0.00,-100.00)	DC
9.	~~**63.73594**~~	(96022809)	AT (100.00, 0.00)	DC	49.	~~**62.76951**~~	(97121909)	AT (100.00, 0.00)	DC
10.	~~**63.68734**~~	(99120716)	AT (100.00, 0.00)	DC	50.	62.74012	(00022608)	AT (-100.00, 0.00)	DC
11.	~~**63.58372**~~	(99082419)	AT (-100.00, 0.00)	DC	51.	62.72754	(99031508)	AT (0.00,-100.00)	DC
12.	~~**63.44833**~~	(99082005)	AT (0.00,-100.00)	DC	52.	62.72545	(00122108)	AT (0.00, 100.00)	DC
13.	~~**63.41516**~~	(00021609)	AT (100.00, 0.00)	DC	53.	62.71577	(98111617)	AT (-100.00, 0.00)	DC
14.	~~**63.39690**~~	(98041819)	AT (100.00, 0.00)	DC	54.	62.69680	(98120517)	AT (-100.00, 0.00)	DC
15.	~~**63.31585**~~	(00101608)	AT (-100.00, 0.00)	DC	55.	62.69494	(00031922)	AT (-100.00, 0.00)	DC
16.	~~**63.22644**~~	(99120416)	AT (100.00, 0.00)	DC	56.	~~**62.69208**~~	(97020705)	AT (100.00, 0.00)	DC
17.	~~**63.22321**~~	(00062102)	AT (0.00, 100.00)	DC	57.	62.68309	(99052302)	AT (0.00,-100.00)	DC

18. **~~63.16488~~** (99082621) AT (-100.00, 0.00) DC
19. **~~63.16318~~** (98050824) AT (0.00,-100.00) DC
20. **~~63.14574~~** (98110617) AT (100.00, 0.00) DC
21. **~~63.12983~~** (00061501) AT (0.00, 100.00) DC
22. **~~63.11957~~** (97021907) AT (0.00, 100.00) DC
23. **~~63.11029~~** (98061121) AT (-100.00, 0.00) DC
24. **~~63.10670~~** (98041419) AT (-100.00, 0.00) DC
25. **~~63.07385~~** (00061323) AT (-100.00, 0.00) DC
26. **~~63.06678~~** (99061005) AT (-100.00, 0.00) DC
27. **~~63.05209~~** (00050506) AT (100.00, 0.00) DC
28. **~~63.04682~~** (98062524) AT (-100.00, 0.00) DC
29. **~~63.04501~~** (00102423) AT (0.00,-100.00) DC
30. 62.98217 (99101719) AT (0.00,-100.00) DC
31. **~~62.96085~~** (98022718) AT (-100.00, 0.00) DC
32. **~~62.96041~~** (00030618) AT (0.00, 100.00) DC
33. 62.94170 (98112009) AT (0.00,-100.00) DC
34. 62.91700 (00121621) AT (-100.00, 0.00) DC
35. 62.91359 (99121305) AT (0.00,-100.00) DC
36. 62.91128 (00031921) AT (-100.00, 0.00) DC
37. 62.89389 (98120509) AT (-100.00, 0.00) DC
38. 62.86679 (99081902) AT (0.00,-100.00) DC

58. 62.68141 (00040721) AT (-100.00, 0.00) DC
59. 62.67597 (98012103) AT (0.00,-100.00) DC
60. 62.65615 (00022519) AT (-100.00, 0.00) DC
61. **~~62.65247~~** (96060824) AT (-100.00, 0.00) DC
62. 62.65057 (00121322) AT (-100.00, 0.00) DC
63. 62.63590 (00122401) AT (0.00, 100.00) DC
64. 62.61233 (99031001) AT (0.00,-100.00) DC
65. 62.57222 (00061504) AT (0.00, 100.00) DC
66. 62.57042 (98090203) AT (0.00, 100.00) DC
67. 62.56813 (00082419) AT (0.00,-100.00) DC
68. **~~62.53071~~** (96091702) AT (0.00,-100.00) DC
69. 62.52769 (97060203) AT (-100.00, 0.00) DC
70. **~~62.51928~~** (96112822) AT (0.00, 100.00) DC
71. 62.51467 (99092418) AT (0.00,-100.00) DC
72. 62.48830 (00013102) AT (100.00, 0.00) DC
73. 62.48801 (00092303) AT (-100.00, 0.00) DC
74. 62.47909 (00121104) AT (0.00,-100.00) DC
75. 62.47895 (00092301) AT (-100.00, 0.00) DC
76. 62.47134 (00090207) AT (0.00,-100.00) DC
77. **~~62.46949~~** (96112822) AT (100.00, 0.00) DC
78. 62.43554 (98122101) AT (-100.00, 0.00) DC

39.	62.83199	(00022101)	AT (100.00, 0.00)	DC	79.	62.43499	(96042105)	AT (100.00, 0.00)	DC
40.	62.82443	(98111003)	AT (-100.00, 0.00)	DC	80.	62.42564	(99121509)	AT (0.00, 100.00)	DC

Table B.2.: Maximum 100 24-Hr Average Concentration Values (only 80 shown; compliance point block-highlighted)

RANK	CONC	(YYMMDDHH)	AT RECEPTOR(XR,YR)	OF TYPE	RANK	CONC	(YYMMDDHH)	AT RECEPTOR(XR,YR)	OF TYPE
1.	~~**48.10681**~~	(98020424)	AT (0.00,-100.00)	DC	41.	36.57086	(00050224)	AT (0.00,-100.00)	DC
2.	**47.52893**	**(98020524)**	AT (0.00,-100.00)	DC	42.	36.31826	(98103124)	AT (50.00,-100.00)	DC
3.	43.21863	(98012224)	AT (-100.00, -50.00)	DC	43.	36.28111	(97011424)	AT (50.00, 50.00)	DC
4.	~~**40.01320**~~	(97031524)	AT (100.00, 0.00)	DC	44.	36.19683	(99010424)	AT (50.00, 50.00)	DC
5.	39.50042	(98110224)	AT (50.00,-100.00)	DC	45.	36.11743	(98032124)	AT (-50.00, -50.00)	DC
6.	~~**39.31218**~~	(00041724)	AT (-100.00, 0.00)	DC	46.	36.02768	(99092124)	AT (0.00,-100.00)	DC
7.	39.21030	(00042424)	AT (0.00,-100.00)	DC	47.	35.96717	(98021324)	AT (0.00,-100.00)	DC
8.	39.20195	(00071124)	AT (0.00,-100.00)	DC	48.	35.92574	(98020624)	AT (50.00,-100.00)	DC
9.	~~**39.06937**~~	(99012224)	AT (-100.00, 0.00)	DC	49.	35.58223	(99011424)	AT (-50.00,-100.00)	DC
10.	38.69060	(98022524)	AT (50.00, -50.00)	DC	50.	35.57988	(96121924)	AT (100.00, 0.00)	DC
11.	38.66324	(99122324)	AT (100.00, 0.00)	DC	51.	35.50787	(97021024)	AT (100.00, 0.00)	DC
12.	38.58439	(97081824)	AT (0.00,-100.00)	DC	52.	35.47686	(96110824)	AT (50.00,-100.00)	DC
13.	38.49494	(99010524)	AT (100.00, 50.00)	DC	53.	35.47508	(96040524)	AT (50.00,-100.00)	DC
14.	38.38240	(98022424)	AT (50.00,-100.00)	DC	54.	35.36801	(99112824)	AT (100.00, 0.00)	DC
15.	38.33889	(99081824)	AT (0.00,-100.00)	DC	55.	35.32301	(00122224)	AT (100.00, 50.00)	DC

16. 38.33855 (97121024) AT (-100.00, -50.00) DC

17. 38.30874 (99032524) AT (0.00,-100.00) DC

18. ~~**38.23639**~~ (99020424) AT (50.00,-100.00) DC

19. 38.17769 (00120124) AT (0.00,-100.00) DC

20. 38.17244 (98101024) AT (50.00,-100.00) DC

21. 38.16967 (99121724) AT (100.00, 0.00) DC

22. ~~**38.11966**~~ (96100924) AT (50.00,-100.00) DC

23. 37.95693 (98100624) AT (-100.00, 0.00) DC

24. 37.84420 (98011624) AT (0.00,-100.00) DC

25. 37.72802 (96091824) AT (50.00,-100.00) DC

26. 37.70357 (98123124) AT (100.00, 50.00) DC

27. 37.70138 (99022124) AT (0.00,-100.00) DC

28. 37.68097 (98040524) AT (50.00,-100.00) DC

29. 37.40958 (00102824) AT (0.00,-100.00) DC

30. 37.38273m(99102524) AT (50.00, 50.00) DC

31. 37.35784 (97020624) AT (100.00, 0.00) DC

32. 37.30082m(99010424) AT (100.00, 50.00) DC

33. 37.23205 (96101024) AT (50.00,-100.00) DC

34. 37.04751 (00110524) AT (0.00,-100.00) DC

35. 36.90880 (99031324) AT (50.00,-100.00) DC

36. 36.87509 (97041924) AT (50.00,-100.00) DC

56. 35.25390 (99042424) AT (0.00,-100.00) DC

57. 35.24054 (98122324) AT (100.00, 50.00) DC

58. 35.20003 (97091024) AT (-100.00, 50.00) DC

59. 35.19956 (96030624) AT (0.00,-100.00) DC

60. 35.14633 (97011124) AT (100.00, 50.00) DC

61. 35.09946 (96110124) AT (100.00, 50.00) DC

62. 35.09356 (99031324) AT (0.00,-100.00) DC

63. 35.01658 (00111824) AT (100.00, 0.00) DC

64. 34.99058 (96010224) AT (0.00,-100.00) DC

65. 34.98722 (97011324) AT (100.00, 50.00) DC

66. 34.98309 (98101124) AT (50.00,-100.00) DC

67. 34.89045 (00011724) AT (0.00,-100.00) DC

68. 34.84517 (97070424) AT (100.00, 0.00) DC

69. 34.70854 (98040624) AT (50.00,-100.00) DC

70. 34.65571 (98013024) AT (50.00, -50.00) DC

71. 34.63356 (98071024) AT (50.00,-100.00) DC

72. 34.59713 (98031024) AT (50.00, -50.00) DC

73. 34.57745 (98032724) AT (50.00, 50.00) DC

74. 34.46351 (99011324) AT (0.00,-100.00) DC

75. 34.36126 (99031924) AT (50.00, -50.00) DC

76. 34.32848 (98010324) AT (50.00, 50.00) DC

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37. 36.84701 (99121424) AT (-100.00,   0.00) DC  77. 34.26509 (97011124) AT (  50.00,  50.00) DC
38. 36.71939 (99022024) AT (   0.00,-100.00) DC  78. 34.18020 (98030824) AT (-100.00,   0.00) DC
39. 36.71157 (98090824) AT (  50.00,-100.00) DC  79. 34.09071 (97110924) AT (  50.00,-100.00) DC
40. 36.68082 (99091624) AT (   0.00,-100.00) DC  80. 34.06385 (00122824) AT (   0.00,-100.00) DC
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Appendix B. INSTRUCTIONS ON THE USE OF THE MODELS IN THE "APPENDIX TO REGULATION 346" (Appendix to Regulation 346 Models)

APPENDIX B: Instructions on the Use of the Models in the "Appendix to Regulation 346"

1.0 Introduction and Applicability

Ontario Regulation 346 was the previous legislation under the *Ontario Environmental Protection Act* that regulated local air quality in the province of Ontario. The Appendix to Regulation 346 contains a mathematical description of three dispersion model calculations which were to be used to demonstrate compliance with MOI Point of Impingement (POI) Limits. Two of those models, the Virtual Source model and the Point Source model have been translated into a software program known as the Regulation 346 Dispersion Modelling Package which is made available by the Ministry of the Environment.

O.Reg.346 was replaced with Ontario Regulation 419 on November 31st, 2005. Section 6(1) paragraphs 1 though 5 of O.Reg.419 present the list of approved dispersion models that, depending on a facility's industrial classification (NAICS Code), may be used to demonstrate compliance with MOE POI Limits, as defined in section 2 of the Regulation. "*The method of calculation required by the Appendix to Regulation 346, if section 18 or 19 applies to the discharges..*" is specified in paragraph 5, and thus is an approved dispersion model for applicable facilities, and is used to demonstrate compliance only with Schedule 1 or Schedule 2 standards and guidelines.

2.0 The Regulation 346 Dispersion Modelling Software

The Regulation 346 dispersion model is a simple, yet effective tool for calculating short term (1/2 hour) maximum contaminant concentrations that result from contaminant emissions to air. The software package has been setup to search through the range of meteorological conditions specified in the regulation, at all ground level receptors located off the facility's property to identify the meteorological condition which will give the highest half-hour average concentration at a Point of Impingement. In addition the Regulation 346 Package can calculate the concentration at specific Points of Impingement, such as air intakes on the roofs of nearby buildings or impingement on the sides or roof of an apartment building.

For most industrial operations, the POI at which the maximum half-hour concentration will occur is typically located on or beyond the facility property line. In some instances, emissions from adjacent properties or facilities are modelled together as a single facility with a single property boundary that includes all adjacent properties. The requirements for adjacent properties are outlined in section 4 of O.Reg.419. Where there is a potential for Same Structure Contamination, the concentration may need to be assessed inside the property line, using an additional approved dispersion model as detailed in section 9(1) of Regulation 419.

2.1 Model Sources

For the typical circumstance where the POI is located at or beyond a company's property-line the sources will be modelled as either virtual sources or point sources. The difference between whether a source can be considered a point or virtual source is determined by whether or not the release of the pollutant is mixed into the region beside a building due to the strong turbulent air currents near the building.

The key concept in deciding between a point and virtual source is the maximum building height. For the situation where the facility is a large rectangular structure the maximum building height will be the height of the highest point on that building excluding stacks, masts or small structures such as elevator penthouses. The following rules distinguish a point from a virtual Source:

- A source can be considered a point source if the stack height above ground is more than twice the maximum building height (for buildings less than 20 metres high) otherwise the source is a virtual source;

- For a building greater than 20 metres high, the source is treated as a point source if the stack height is more than 20 metres above the roof height otherwise the source is a virtual source;

- An additional criterion occurs when a nearby tall building is upwind of the emission source. If a building higher than the height of the stack above the ground is within 100 m of the stack then when the wind blows from the tall building toward the emission source, the source is treated as a virtual source due to the tall building.

- Fugitive emissions from open sources from which the emissions are mixed into a volume of air prior to dispersing are typically modelled as virtual sources. Examples include roadways and material handling sources such as stockpile formation and vehicle loading.

2.1.1 Modelling with Virtual Sources

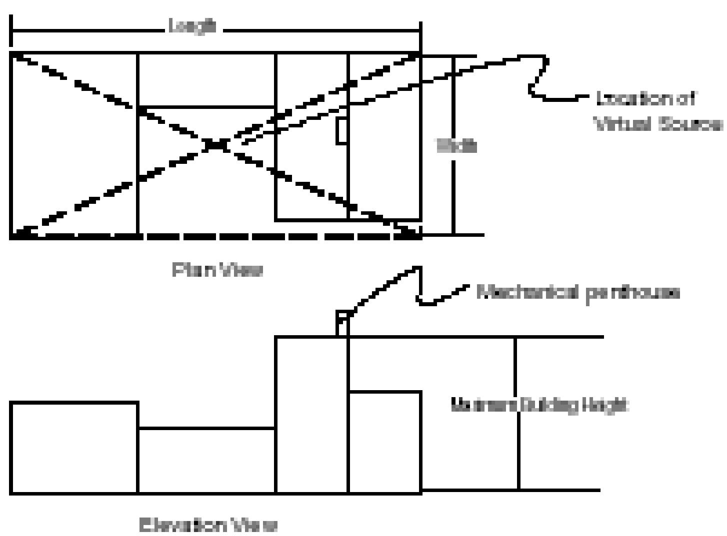
For a virtual source associated with a building, the emissions are assumed to be mixed into the turbulent region beside the building. An initial horizontal and vertical mixing which depends on the height and the width of the building is then used in the calculations. For virtual sources, the maximum concentration will occur along the property line. The parameters used in a virtual source calculation are: the contaminant emission rate, the maximum width, length and height (usually the maximum building height) of the virtual source, the location of the geometric centre of the virtual source, the orientation angle of the Virtual Source and the location of the property line.

The terms length and width have very specific meanings in the Appendix to Regulation 346. For the case when the building (or source) is parallel to the x-axis (an orientation angle of zero degrees) the length is the building (or source) dimension in the

x-direction or left-to-right direction when the plan view of the building (or source) is observed as a Cartesian coordinate system; while the width is the dimension in the y-direction or up-and-down direction, and the location of the virtual source is the centre of the building (or source) when observed in the plan view.

For situations where the plant is a series of different buildings or sources the dispersion calculation can encompass all of them as one virtual source provided they are all connected or within 5 metres of each other. For these complicated virtual sources it is helpful to superimpose the rectangular shape of the Virtual Source on a copy of the plan view of the facility. The dimensions of the virtual source will be those of the smallest rectangle that can be constructed to encompass the contiguous structure. The maximum building (or source) height will be the height of the highest point on any of the structures that make up the overall virtual source excluding stacks, masts or small structures like elevator penthouses; and the location of the virtual source is the centre of the single rectangular building (or source) when observed in the plan view. Figure C.2.1 is an example of a virtual source that encompasses a number of individual buildings or tiers.

Figure C.2.1: Example Virtual Source

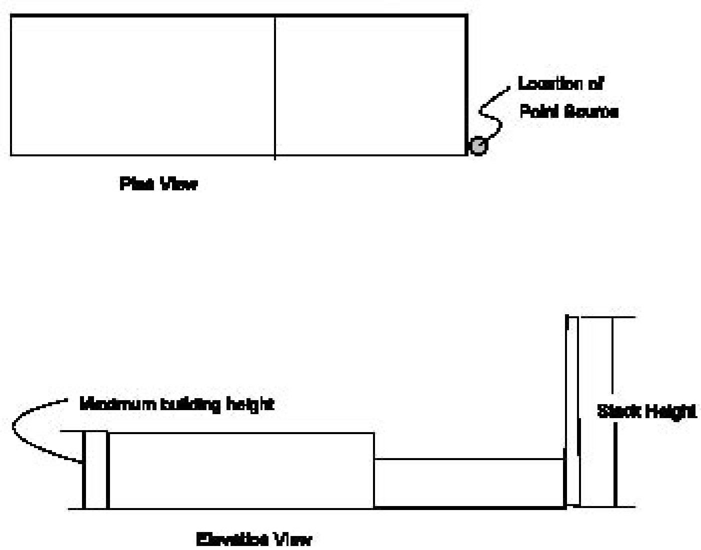


2.1.2 Modelling with Point Sources

If the discharge takes place outside of the turbulent air currents near the building the emission would travel downwind as an elevated plume and then mix down to ground level some distance away. This elevated plume emission is known as a point source. For point sources the emissions released from the stack top will travel downwind as an elevated plume. The material would be slowly mixed horizontally and vertically. At some distance from the stack, the material would be mixed down to ground level

resulting in the ground-level concentration maximum occurring a distance from the stack. Because emissions from a point source would have to be mixed horizontally and vertically over a significant volume before the plume is mixed to ground level, a given emission rate usually results in a smaller maximum ground-level concentration if it is released from a point source as opposed to a virtual source. The maximum concentration typically occurs at some distance away from the source usually also some distance away from the property-line. The important parameters used in a point source are: the contaminant emission rate, the discharge velocity, the discharge temperature, the stack diameter, the stack height and the stack location, the location of the property line and the location of any off site receptors that the plume may impact on. The emission source is treated as a point source if the stack is higher than the criteria described above. Figure C.2.2 shows an example of a point source.

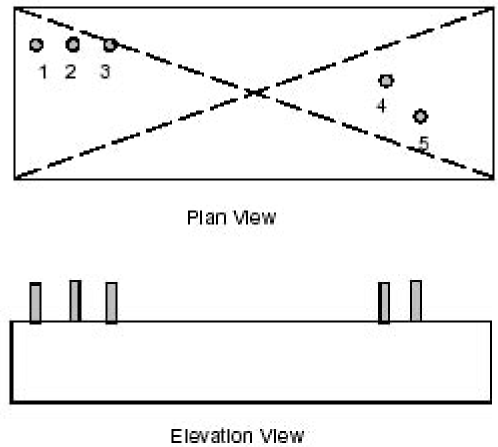
Figure C.2.2: Example Point Source



2.1.3 Single Dispersion Sources

In the common circumstance where all emissions from a facility are emitted as a single virtual source, there is a very useful shortcut that can be employed. Since for a virtual source the emissions discharged from a building are released into the turbulent zone around the building all the discharges can be lumped together and considered to be emitted from a common virtual source (Figure C.2.3).

Figure C.2.3: Example - Single Virtual Source Scenario



For this source configuration the emissions from Sources 1, 2, 3, 4 & 5 can be lumped together to be emitted from the one virtual source.

If these are the only sources then the dispersion calculation can be further simplified by running the virtual source once for a unit emission rate of 1 g/s. The resultant POI concentration at the property line can be used as a dispersion factor where the product of the dispersion factor and a contaminant emission rate is the POI concentration of that contaminant at the property line.

2.1.4 Complex Modelling Scenarios

While many industrial facilities can be described as a single virtual source there are other situations where a contaminant is emitted by more than one virtual or point source or a combination of many virtual and point sources. For these situations the modelling exercise is more complicated.

When there is more than one distinct virtual or point source that is emitting the contaminant the dispersion modelling exercise must be carried out for all the sources together and repeated for each individual contaminant.

2.2 Same Structure Contamination if Sections 18 or 19 of O.Reg.419 Apply

For most industrial operations, compliance with the point of impingement at which the maximum half-hour concentration will occur will be on or beyond the property line. There are, however some circumstances where the concentration needs to be assessed inside the property line (same structure contamination). This circumstance often occurs when the source is in an industrial mall, where the impact of contaminants released by tenants at one unit is assessed in terms of their impact on other neighbouring tenants in the building. The Regulation 346 model includes a very

simplified calculation to estimate possible impacts of emission releases on air intakes, open doors or windows on the source's own building. This approach can be used to assess same structure contamination if sections 18 or 19 of Regulation 419 apply to discharges from a facility.

Regulation 346 addresses same structure contamination through use of the Scorer-Barrett equation. Concentrations depend on the stretched string distance from the release point of the emission source to the receptor (i.e., an air intake, a doorway or an operable window). The stretched string distance is the shortest distance from the release point to the receptor without intercepting the building.

$$\text{Concentration } (\mu g/m^3) = 0.6 \times 10^6 \times \text{Emission Rate } (g/s)/L^2$$

Where,

L = 1.57 times the stretched string distance in metres (if the receptor is lower than the emission point);

otherwise,

L = the stretched string distance.

Note that the Scorer-Barrett equation may only be used by facilities for which section 18 or 19 applies. Facilities subject to section 20 of the Regulation (i.e. those required to use the US EPA models) are required to use the ASHRAE method for assessment of same structure contamination.

2.3 Models in the Appendix to Regulation 346 Dispersion Modelling Package

Although there are ten programs included in the software package, only the first four programs are needed to assess compliance with Schedule 1 or 2 MOE POI Limits. Briefly, the purposes of those four programs in the Regulation 346 Dispersion Modelling Package are:

Table C.2-1: Dispersion Modelling Software Package for the Models in Appendix to Regulation 346

Source Data Manager	Used to input information on the facility's property line coordinates and on the emission source characteristics.
Point of Impingement Manager	Used to input information on the location of nearby buildings.
Maximum Ground Level Concentration	This program uses the files produced in the Source Data Manager and calculates the maximum half hour Point of Impingement concentration outside of the facility's property.
Concentrations at Points:	This program uses information from both data manager programs, (1) and (2), and calculates the maximum concentration at each receptor given in the Point of Impingement Manager.

This Table contains two columns with no row headings. The first column contains terms commonly used in the software, the the second column contains the corresponding description.

<u>List of Routines:</u>

1. Source Data Manager
2. Point of Impingement Data Manager
3. Maximum Ground Level Concentration
4. Concentration at Points
5. Required Stack Height
6. Isopleths
7. Contour Printout
8. Contour Plot
9. General Concentration Plot
10. Interpolation

Typical Inputs: Input default values are displayed within square brackets.

2.3.1 Description and Objective of the Various Programs and Routines

41. Source Data Manager

Used to input the source and property line information in advance of running the concentration program. The output is stored in a file for later editing or use. This

routine is essential if a property line is to be defined. It can also save a lot of typing time if multiple sources are to be run more than once.

42. Point of Impingement Data Manager

    Used to input the points of impingement in advance of running the concentration program. The output is stored in a file for later editing or use. This routine is not essential, but can save a lot of typing time if multiple receptors are to be run more than once.

43. Maximum Ground Level Concentration

    Used to compute the maximum ground level concentration from any combination of sources. If the property line has been defined, the program computes the maximum concentration off-property and on the property line. No point of impingement data is required.

44. Concentration at Points

    Used to compute the maximum concentration from any combination of sources at any combination of points of impingement. Both source and point of impingement data are required as input.

45. Required Stack Height

    Used to compute the height of stack required so that the maximum concentrations at ground level, at the property line and at points of impingement meet a specified standard. The program computes the height for only 1 source at a time.

46. Isopleths

    Used to compute concentration isopleths for any combination of point sources and Virtual Sources. The isopleths are computed over a grid superimposed over a vertical or horizontal plane. You may specify a particular stability, wind direction and wind speed. The result, stored in non-readable form, can be printed using Contour Printout or plotted using Contour Plot.

47. Contour Printout

    Used to print the results of an Isopleth or Interpolation run in readable form. Can be used to view contour results if a plotter is not available.

48. Contour Plot

    Used to plot the contours of a file created by Isopleth or Interpolation. The result can be routed to a plotter or to an output file (in non-readable form) for later plotting.

49. General Concentration Plot

Used to compute and plot concentrations for any combination of sources. The concentrations are plotted along a line between two arbitrary endpoints. You may specify a particular stability, wind direction and wind speed. The result can be outputted to a plotter or to an output file (in non-readable form) for later plotting.

50. Interpolation

    Used to compute values over regularly spaced, points. The output is written to a file in non-readable form. The file can be subsequently outputted using Contour Printout or plotted using Contour Plot.

2.3.2 Model Input Parameters

Input parameters for the various routines are summarized below:

1. Titling Information

   e.g. Date, Title. All are optional. Be sure, though, to enter an output filename as the first input or else the program output will default to the printer.

2. Point/Virtual Source

   Indicates whether the source is a point source (e.g. a stack) or a virtual source (e.g. emission from a building vent).

3. Emission Rate

   In grams/second. For a single source, concentration (in ug/m^3) is directly proportional to the emission rate.

4. Stack Height

   Enter the height of the stack from ground level to the top of the stack.

5. Stack Diameter

   Enter the inner stack diameter.

6. Stack Exit Gas Velocity

   If unknown, can be computed from flow rate and stack diameter.

7. Coordinates

   A local coordinate system is typically defined for the site. For example, this can be done by arbitrarily defining (0,0) at, the location of the largest source, or alternatively (0,0) could be defined as the location of the lower left corner of the property. All

other coordinates are in metres, with the X-axis often chosen to represent the east-west direction.

8. Building Width/Length/Orientation

   The building width is the shorter dimension. The building length is the longer dimension. The orientation is the acute angle formed by the building length intersecting the X-axis (default of 0 degrees). A counter-clockwise rotation increases the orientation.

9. Open/Closed Receptor

   Used when entering an elevated (i.e. above ground level) receptor. A closed receptor will only allow concentration to be computed at the height specified. An open receptor will allow a search from ground level to the height specified for the maximum concentration at that (x,y) location.

10. Selecting the Appropriate Building Height

    Since many building have varying heights, it is important to select the appropriate building height relative to the wind direction and influence of taller portions of the building (or sections of a building) within a specific are of influence. Based upon information within the US EPA's "User's Guide for the Industrial Source Complex (ISC3) Dispersion Models – Volume II – Description of Model Algorithms, September 1995", the area of influence as a result of the taller portion of the building will be defined by a function of the distance L (where L is the lesser of the building height or the projected building width)…

    - a distance of 5 times L from the edge of the taller portion for areas <u>down-wind</u> of the taller portion;
    - a distance of 2 times L from the edge of the taller portion for areas <u>up-wind</u> of the taller portion; and
    - a distance of 0.5 times L from the taller portion for areas parallel to the taller portion.

    As discussed previously, for virtual sources the selected building height should be the height of the tallest building tier excluding stacks, masts or small structures such as elevator penthouses.

Table C.2-2: Summary of Commands for the Models in the Appendix to Regulation 346

<u>SDBMGR Commands</u>

The SDBMGR command options are as follows:

RS - reset: prepares the program for a new data set;

IN - input: input a source data set;

ED - edit: edit a source data set; and

LI - list: list a source data set.